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ABSTRACT

This curriculum guide contains six units of instruction for a course in domestic refrigerator, freezer, and window air conditioner service. The units cover the following topics: (1) service fundamentals; (2) mechanical components and functions; (3) electrical components and control devices; (4) refrigerator and freezer service; (5) domestic ice maker service; and (6) window air conditioner service. Each of the units contain some or all of the following basic components of a unit of instruction: objective sheet, suggested activities for the teacher, answers to assignment sheets, answers to written test, written test, unit evaluation form, teacher supplements, transparency masters, information sheet, student supplements, assignment sheets, and job sheets. All the unit components focus on measurable and observable learning outcomes, and are planned to be used in more than one lesson or class period of instruction. In addition, the guide the following: includes suggestions for using the materials; national Vocational Industrial Clubs of America competencies; foundation skills and competencies identified by the Secretary's Commission on Achieving Necessary Skills (SCANS); a competency profile; instructional and task analyses; and a tools, equipment, and materials list. Contains eight references. (KC)

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Teacher Edition

The Multistate Academic and Vocational Curriculum Consortium

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Domestic Refrigerator, Freezer and Window Air Conditioner Service

Teacher Edition

Table of Contents

Foreword v
Acknowledgements vii
Use of introductory materials ix
Use of this publication xi
National VICA competencies xv
SCANS foundation skills and competencies definitions xxi
Competency profile xxv
Instructional/task analysis xxix
SCANS foundation skills xxxv
Tools, equipment, and materials list xxxix
References xliii

Unit 1: Service Fundamentals 1
Unit 2: Mechanical Components and Functions 25
Unit 3: Electrical Components and Control Devices 51
Unit 4: Refrigerator and Freezer Service 81
Unit 5: Domestic Ice Maker Service 209
Unit 6: Window Air Conditioner Service 251

Disclaimer

This text presents information about the tools, equipment, and procedures typically used in servicing domestic refrigerators, freezers, ice makers, and window air conditioners. The information is intended for presentation and demonstration by an experienced instructor in a classroom/lab environment designed for the safety of students and equipment. Because training activities vary with local implementation, the writer and publisher disclaim liability for use of these materials for other than their intended purposes.

Foreword

ACR service companies want technicians with a broad range of skills, but they hire technicians whose expertise includes a winning smile and an understanding attitude. In a nutshell, service companies want technicians who excel at customer relations.

The service work orders in this text teach technicians to respect service records as the essential link between service and good customer relations. We feel that *Domestic Refrigerator, Freezer, and Window Air Conditioner Service* will update your program and encourage students to add domestic service skills to their performance competencies.

And because the good service that promotes good customer relations means good troubleshooting skills, this text is loaded with troubleshooting guides that chart step by step solutions to problems ranging from easy to tough. Truth is, we don't know of another text that presents troubleshooting in such detail as this text does. It's another reason we feel *Domestic Refrigerator, Freezer, and Window Air Conditioner Service* will serve program needs better than any other text available.

As good as the text is, you will still need to adapt it to your individual program needs, localize it to meet area job conditions, and supplement it with innovative demonstrations that motivate students. And even as we write of an excellent text, we know that you may discover items that need attention. Share your opinions with us by calling MAVCC toll-free at 1-800-654-3988. We want to hear from you.

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Multistate Academic and
Vocational Curriculum Consortium

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Vocational Curriculum Consortium

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The resource committee which met to review and revise MAVCC's original *Air Conditioning and Refrigeration Domestic Refrigeration* recommended significant changes that are reflected in this new text. The text also notes new EPA regulations that apply to domestic refrigeration service. For recognizing changing training needs, we thank those instructors and industry members who provided outstanding direction for this new text, *Domestic Refrigerator, Freezer, and Window Air Conditioner Service.*

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Use of Introductory Materials

Introductory materials are included in the teacher edition only and contain useful information to assist administrators and teachers in planning for instructions.

In addition to the general information such as the table of contents, foreword, and acknowledgements, information is included on the following:

1. **Use of this publication**—Explains the components of a unit of instruction and how they should be used as part of the teaching/learning process.
2. **Competency profile**—Provides a record of student performance for each task included in a unit of instruction. This becomes a part of the student's permanent records and should be utilized when directing the student toward employment opportunities.
3. **Instructional/task analysis**—Provides a quick review of contents of the publication; identifies cognitive (knowledge) skills and psychomotor (doing) skills addressed in each unit of instruction.
4. **Related academic and workplace skills list**—Classifies unit tasks (assignment sheets and job sheets) according to related academic and workplace skills and competencies being reinforced. Skill areas reflected by skill groups, sub skills, and definitions have been identified using *What Work Requires of Schools: A SCANS Report for America 2000* and *Workplace Basics: The Skills Employers Want.*
5. **Tools, equipment, and materials list**—Provides a comprehensive list of those items needed to successfully complete the assignment sheets and/or job sheets; assists administrator/teacher in determining program costs.
6. **Reference list**—Provides a comprehensive list of resources used in the development of this publication.

A glossary of terms may also be provided in the introductory materials depending on subject matter and committee recommendations.

As you use these materials, it is hoped that they will provide useful information to meet a variety of needs.

Use of This Publication

Instructional units

Domestic Refrigerator, Freezer, and Window Air Conditioner Service contains six units of instruction. Each instructional unit in a teacher edition includes some or all of the following basic components of a unit of instruction: objective sheet, suggested activities for the teacher, answers to assignment sheets, answers to written test, written test, unit evaluation form, teacher supplements, transparency masters, information sheet, student supplements, assignment sheets, and job sheets.

All of the unit components focus on measurable and observable learning outcomes. Teachers are encouraged to supplement, personalize, localize, and motivate with these materials in order to develop a complete teaching/learning process.

Units of instruction are designed for use in more than one lesson or class period of instruction. Careful study of each unit of instruction by the teacher will help to determine the following:

- Amount of materials that can be covered in each class period.
- Skills that must be demonstrated.
- Amount of class time needed for demonstrations.
- Amount of time needed for student practice.
- Supplementary materials, including print and nonprint media and equipment and supplies, that must be ordered.
- Resource people who must be contacted.

Objective sheet

Each unit of instruction is based on performance objectives which state the goals for successful completion of the course. These performance objectives are stated in two forms: unit objectives which state the expected performance of each student after completion of the unit of instruction, and specific objectives which state what the student must do to reach the unit objective.

The objectives should be provided for students and stressed throughout the teaching/learning process. This will help answer any questions concerning performance requirements for each instructional unit. The objectives can also help determine teaching strategies and instructional methods. Teacher should prepare for each unit by deciding how each objective can best be taught.

Teachers should feel free to modify, delete, or add objectives in order to meet the needs of the students and community. When objectives are added, the teacher should remember to supply the needed information, assignment and/or job sheets, and criterion test items.

Suggested activities

This component is included only in the teacher edition. The suggested activities assist teachers during the preparation stage of the teaching/learning process by providing an instructional plan, teaching suggestions, and a list of supplemental resources. Ways to integrate academic and workplace skills have been included in the teacher suggestions, and skill areas have been noted in bold. The teacher should read the suggested activities before teaching the units and decide how each objective can best be taught. Time should also be allowed to obtain supplemental materials, prepare audiovisual materials, and contact outside resources. Duties of the teacher will vary according to the particular unit.

Suggested activities (cont.)

References used in the development of each unit are listed in the suggested-activities section, along with suggested supplemental resources that may be used to teach the unit. These materials can be used by the teacher to supplement her or his knowledge of the subject area or to help students with particular interests or objectives in the area covered.

Instructions for evaluating student performance on the job sheets are also included in the suggested-activities section. Teachers should select and discuss with students the rating scale that will be used.

Assignment and written test answers

Assignment-sheet answers and written-test answers are designed to assist the teacher in evaluation of student performances.

Written test

This component provides criterion-referenced evaluation of every cognitive objective listed in the unit of instruction. The test appears in the teacher edition only, but duplication is permitted for student use. If objectives have been added, deleted, or modified, appropriate changes should be made on the written test. It is recommended that the tests be divided into shorter tests covering three or four objectives at a time and given soon after those objectives have been covered. A selection of test items from the units covered may be used for final tests at the end of each term if desired.

Unit evaluation form

This sheet provides teachers with a record of each students performance on a unit of instruction. It includes space for assignment sheet ratings, job sheet ratings, written test scores, and teacher comments. The unit evaluation form is included in the teacher edition only, but may be duplicated.

Teacher supplements

This component is included only in the teacher edition. Teacher supplements are optional materials for the teacher to use. They have three purposes: to provide the teacher with higher level materials to stretch the advanced student, with remedial information or practice to assist the less-advanced student, and with state-of-the-art information in which the teacher may not have background or with information that is not readily available in other books. Some teacher supplements may be duplicated for student use and are marked accordingly.

Transparency masters

Transparencies are included in the teacher edition only and are used to direct the students' attention to the topic of discussion. They may provide illustrations, charts, schematics, or additional information needed to clarify and reinforce objectives included in the unit of instruction.

Use of This Publication

Information sheet

The information sheet provides the content essential for meeting the cognitive (knowledge) objectives of the unit. Teachers will find that the information sheet serves as an excellent guide for presenting background knowledge necessary to develop the skills specified in the unit objective. Students should read the information sheet before the information is discussed in class. Space is provided in margins for students and teachers to add notes that supplement, localize, personalize, or provide information for the teaching of each objective.

Student supplements

Student supplements are included in the student edition. The information presented in a student supplement may consist of tables, charts, written information, forms, or other information students will need in order to complete one or more of the assignment and/or job sheets. Students are not directly tested over the information presented in a supplement; however, their ability to apply this information may be evaluated in the completion of assignment sheets and/or job sheets.

Assignment sheets

Assignment sheets provide students with pencil and paper activities that give students the opportunity to make practical application of the knowledge in the information sheet. Criteria are provided to objectively evaluate student performance.

Job sheets

The job sheets provide criteria to objectively evaluate student performance, a list of required equipment and materials, and a step-by-step procedure for performing a psychomotor skill. The teacher should discuss the equipment and materials available in the classroom and/or laboratory and demonstrate the procedure prior to having students practice procedure. When a student is ready to be evaluated, the teacher should follow instructions for evaluating student performance which may be found in the teacher edition.

Job sheets are an important segment of each unit. Job sheets provide potential employers with a picture of the skills being taught during training and the performances that might reasonably be expected from an individual who has had this training.

Disseminating material

Material may be given out a unit or page at a time to keep the material before the student always new. Some teachers ask students to furnish a three-ring binder or folder for the current unit of study. This is convenient for students taking the material home to study. Upon completion, each unit is then placed in a larger binder. Some teachers prefer to store the material by unit in filing cabinets or boxes until needed.

For best results, provide student materials for each student. Student editions contain objective sheets, information sheets, student supplements, assignment sheets, and job sheets. Students should be allowed to take their materials home at the end of the course.

# National VICA Competencies
for
Domestic Refrigerator, Freezer, and Window Air Conditioner Service

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The major VICA competencies for air conditioning and refrigeration were presented in MAVCC's *Fundamentals of Air Conditioning and Refrigeration*. A selected number of those competencies are reprinted here to reflect those general/basic skills also needed by domestic refrigeration service technicians. And because domestic service demands customer service skills, other appropriate VICA competencies have also been addressed. For added convenience, this listing is presented in a unit by unit order.

Unit 1: Service Fundamentals

VICA Section & Title	VICA Competency	Component and Content	Notes
E: Refrigeration Systems	2. Demonstrate knowledge of heat and heat transfer	Objectives 2 & 3 relate domestic service to basic knowledge of refrigeration systems	Objective 1 includes "Terms & Definitions" to enhance literacy
E: Refrigeration Systems	3. Demonstrate knowledge of pressure and temperature	Objectives 3, 4, and 5 present dynamics of design	Subject related to general refrigeration service skills
E: Refrigeration Systems	10. Demonstrate knowledge of refrigeration components	Objective 7 presents data plate information and where to find it	Subject prepares student for activities in a later unit
B: Common Tools and Equipment Applications	14. Demonstrate ability to safely move equipment	Objective 9 presents guidelines for preparing and transporting a refrigerated appliance safely	Subject prepares student for activities in a later unit
M: Management and Entrepreneurship Practices	15. Communicate with consumer	Objective 12 teaches importance of appreciating customer concerns	Student will apply basic customer relations in later job sheets

Unit 2: Mechanical Components and Functions

VICA Section & Title	VICA Competency	Component and Content	Notes
E: Refrigeration Systems	10. Demonstrate knowledge of refrigeration components (compressor)	Objective 3 presents types of compressors used with refrigerators and freezers and how to access them for service	Objective 1 includes "Terms and Definitions" to promote literacy of subject area
E: Refrigeration Systems	10. Demonstrate knowledge of refrigeration components (condensers)	Objective 4 presents types of condensers used with refrigerators and freezers	Discusses plate, fin, and tube-type condensers
E: Refrigeration Systems	10. Demonstrate knowledge of refrigeration components (evaporators)	Objective 5 presents types of evaporators used with refrigerators and freezers	Discusses static, cold-plate, and shell-type evaporators
E: Refrigeration Systems	10. Demonstrate knowledge of refrigeration components (metering devices)	Objective 6 presents the capillary tube and its applications	Discusses how capillary tube is soldered to suction line so it can act as a heat exchanger to increase subcooling or decrease superheat
E: Refrigeration Systems	11. Demonstrate knowledge of refrigeration accessories	Objective 7 presents liquid-line driers, accumulator or receivers, oil coolers, and condensate pans	Discusses component characteristics and applications

Unit 2: Mechanical Components and Functions (cont.)

VICA Section & Title	VICA Competency	Component and Content	Notes
E. Refrigeration Systems	5. Demonstrate knowledge of pressure/temperature effect on matter 6. Demonstrate knowledge of basic compression refrigeration cycle	Objective 8 presents parameters of operating characteristics of refrigerators and freezers including an average/temperature pressure chart Objectives 8 and 9 present equipment and procedures for checking temperatures and pressure	Presents chart with average temperature/pressure conditions of a system operating with R-12 at 70°F and at 90°F Discusses how to best access a system, check temperatures and pressures, and evaluate system performance
E. Refrigeration Systems	8. Demonstrate knowledge of manifold gauge set 9. Demonstrate knowledge of system access	Job Sheet 1 "Attach a Manifold Gauge Set to a Refrigerator or Freezer Using a Line Tap Valve" Job Sheet 2 "Access a Refrigerator or Freezer With a Service Valve Adapter"	Student must follow a step by step procedure, record temperatures and pressures as required
M. Management and Entrepreneurship Principles	11. Complete work orders/reports	Part of Job Sheets 1 and 2	Service Work Order must be completed for customer and for company records

Unit 3: Electrical Components and Control Devices

VICA Section & Title	VICA Competency	Component and Content	Notes
F: Electricity	8. Demonstrate and apply knowledge of electrical components	Objective 2 defines purposes of electrical components and control devices Objective 3 presents temperature controls Objective 4 presents start components	Student required to replace a temperature control in Job Sheet 1
F: Electricity	10. Demonstrate and apply knowledge of wiring diagrams, schematics, and electrical symbols	Assignment Sheet 1 requires student to identify heater circuits Assignment Sheet 2 requires student to identify controls	Assignment Sheet 1 requires reading a schematic Assignment Sheet 2 requires reading a schematic
F: Electricity	8. Demonstrate and apply knowledge of electrical components	Objective 9 defines characteristics and purpose of electric defrost Objective 10 defines characteristics and purpose of hot gas defrost	Student must replace a defrost heater in Job Sheet 2

Unit 4: Refrigerator and Freezer Service

VICA Section & Title	VICA Competency	Component and Content	Notes
E: Refrigeration Systems	6. Demonstrate knowledge of basic compression refrigeration cycle	Objectives 2, 3, and 4 concern gathering information about equipment, type of service, and evaluating and investigating problems	Objective 1 presents "Terms and Definitions" to enhance literary
F: Electricity	8. Demonstrate and apply knowledge of electrical components	Objectives 8 and 9 concern servicing and replacing electrical components	Applications are presented in job sheets

National VICA Competencies

Unit 4: Refrigerator and Freezer Service (cont.)

VICA Section & Title	VICA Competency	Component and Content	Notes
E: Refrigeration Systems	30. Demonstrate knowledge of system cleaning and evacuation procedures	Objectives 10 and 11 concern servicing refrigeration components and repairing refrigerant leaks	Cleaning and evacuation required in job sheets to prepare for other activities
E: Refrigeration Systems	10. Demonstrate knowledge of refrigeration components	Objective 13 presents capillary tube service	Application is presented in a job sheet
F: Electricity	59. Analyze and verify motor failure	Objective 14 presents compressor replacement	Application presented in a job sheet
M: Management and Entrepreneurship Principles	15. Communicate with consumer	Assignment Sheet 1	Student uses troubleshooting guide to find causes of customer complaints
F: Electricity	10. Demonstrate and apply knowledge of wiring diagrams, schematics, and electrical symbols	Assignment Sheet 2	Student identifies circuit problems
E: Refrigeration Systems	16. Install driers	Assignment Sheet 3; student selects driers for given applications	Application presented in a job sheet
E: Refrigeration Systems	10. Demonstrate knowledge of refrigeration components	Assignment Sheet 4; student selects compressors for given applications	Application presented in a job sheet
E: Refrigeration Systems	10. Demonstrate knowledge of refrigeration components	Job Sheet 3	Student Troubleshoots selected problems in a refrigerator or freezer
E: Refrigeration Systems	10. Demonstrate knowledge of refrigeration components	Job Sheet 4	Student checks the efficiency of a compressor
F: Electricity	59. Analyze and verify motor failure	Job Sheets 5 & 6	Student replaces an evaporator fan motor and a condenser fan motor
D: Soldering and Brazing E: Refrigeration Systems	2, Demonstrate knowledge of soldering, brazing, and welding materials and torches 30. Demonstrate knowledge of system cleaning and evacuation procedures	Job Sheet 7 Job Sheet 8 Job Sheet 9 Job Sheet 10	Student completes brazing as needed, replaces a liquid line drier and must evacuate and recharge the system Student also uses epoxy to repair an aluminum evaporator and brazes an aluminum evaporator
D: Soldering and Brazing	3. Join similar and dissimilar metals	Job Sheet 11	Student replaces an aluminum-to-aluminum swage joint or an aluminum-to-copper swage joint
E: Refrigeration Systems	16. Install driers	Job Sheet 12	Student installs a liquid-line drier
E: Refrigeration Systems	31, Charge system according to manufacturers standards	Job Sheets 13 and 14	Student charges a refrigerated appliance using a charging cylinder and using scales
E: Refrigeration Systems	10. Demonstrate a knowledge of refrigeration components	Job Sheet 15	Student services or replaces capillary tube to include replacing liquid-line drier, leak testing the system, evacuating, and charging
		Job Sheet 16	Student replaces compressor to include replacing both liquid-line and suction-line driers, leak testing, evacuating, and charging

Unit 4: Refrigerator and Freezer Service (cont.)

VICA Section & Title	VICA Competency	Component and Content	Notes
M: Management and Entrepreneurship Principles	11. Complete work orders reports	All job sheets	Student completes Service Work Order with each job sheet to provide records for company bookkeeping and for customers

Unit 5: Domestic Ice Maker Service

VICA Section & Title	VICA Competency	Component and Content	Notes
E: Refrigeration Systems	11. Demonstrate knowledge of refrigeration accessories	Objectives 2, 3, 4, 5, & 6 present characteristics of basic types of ice maker: crescent-shaped, five-cavity, and flex-tray and components for storing and dispensing ice	Student must identify parts of basic ice maker types presented in later objectives
E: Refrigeration Systems	11. Demonstrate knowledge of refrigeration accessories	Objectives 10 and 11 present ice maker troubleshooting and service	Student troubleshoots according to customer complaints
M: Management and Entrepreneurship Principles	15. Communicate with consumer	Assignment Sheet 1 has a student use a troubleshooting guide to solve problems	
E: Refrigeration Systems	26. Install water regulating valves	Job Sheet 1 requires student to install a water line to a refrigerator; Job Sheet 2 requires to disassemble and clean a water fill valve; Job Sheet 7 requires student to adjust water valve switch in Flex-tray ice maker	Job sheets require special equipment and water container graduated in cc's
E: Refrigeration Systems	10. Demonstrate knowledge of refrigeration components	Job Sheets 3, 4, and 5	Student replaces a thermostat, a mold heater, and a seal, bearing, and retainer; job sheets require special equipment

Unit 6: Window Air Conditioner Service

VICA Section & Title	VICA Competency	Component and Content	Notes
E: Refrigeration Systems	10. Demonstrate knowledge of refrigeration components	Objective 3 presents mechanical components of a window air conditioner	Student applies information in a job sheet
F: Electricity	8. Demonstrate knowledge of electrical components	Objective 4 presents electrical components of a window air conditioner	Student applies information in a later job sheet
E: Refrigeration Systems	6. Demonstrate knowledge of basic compression	Objective 11 presents parameters for evaluating system performance	Student applies information in a later job sheet
F: Electricity	8. Demonstrate knowledge of electrical components	Objective 14 concerns servicing electrical components and Objective 15 concerns replacing electrical components	Student services and replaces electrical components in later job sheets
M: Management and Entrepreneurship Principles	15. Communicate with consumer	Assignment Sheet 1	Student uses a troubleshooting chart to find problems indicated by a customer

National VICA Competencies

Unit 6: Window Air Conditioner Service (cont.)

VICA Section & Title	VICA Competency	Component and Content	Notes
B: Common Tools and Equipment Applications	10. Use shop rags 11. Use vacuum cleaners 12. Use cleaners, solvents, and lubricants	Job Sheet 1 Job Sheet 2	Student installs a window air conditioner and cleans a window air conditioner
F: Electricity	58. Demonstrate knowledge of troubleshooting and apply motor diagnosing techniques	Job Sheet 3	Student replaces a fan motor
F: Electricity	52. Install motor starting devices	Job Sheet 4	Student installs a hard start kit
E: Refrigeration Systems	31. Charge systems according to manufacturer's standards	Job Sheet 7 Job Sheet 8	Student charges system with charging cylinder and charges system with charging scales
E: Refrigeration Systems	32. Evaluate system performance in accordance with manufacturer's specifications	Job Sheet 9	Student evaluates system charge using a superheat chart
E: Refrigeration Systems	15. Demonstrate knowledge of fixed orifice metering devices	Job Sheet 10	Student services a capillary tube
E: Refrigeration Systems	16. Install driers (liquid and suction line service)	Job Sheet 6	Student replaces a liquid line filter-drier

SCANS Foundation Skills and Competencies

Skill Groups	Sub Skills	Definitions
Basic Skills	Reading	Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task.
	Writing	Communicating a thought, idea or fact in written form in a clear, concise manner.
	Arithmetic/ mathematics	Performing basic computations, applying, estimating, and reasoning skills, and solving practical problems using a variety of mathematical techniques.
	Science	Applying knowledge learned through study or practice that is based on scientific principles as they relate to specific tasks.
	Listening	Receiving, interpreting, and responding to verbal messages and other cues.
	Speaking	Communicating a thought, idea, or fact verbally in a clear, concise manner.
Thinking Skills	Creative thinking	Using imagination to generate new ideas.
	Decision making	Specifying goals and constraints, generating alternatives, considering risks and evaluating and choosing the best alternative.
	Problem solving (critical thinking)	Recognizing and defining problems, devising, and implementing plan of action and tracking and evaluating results.
	Seeing things in the mind's eye	Mentally organizing and processing symbols, pictures, graphs, and other information.
	Knowing how to learn	Using efficient learning techniques to acquire and apply new knowledge and skills.
	Reasoning	Applying a rule or principle underlying the relationship between two or more objects when solving a problem.
Personal Management Skills	Responsibility	Exerting a high level of effort towards goal attainment, working, hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration.
	Self-esteem	Developing self-confidence and maintaining a positive view of self.
	Career awareness, development and mobility	Assessing self accurately, setting personal goals, establishing and implementing a plan, and monitoring progress.

Skill Groups	Sub Skills	Definitions
Personal Management Skills (cont.)	Integrity/honesty	Choosing an ethical course of action when faced with making a decision that may break with personal or societal values and recognizing the impact of violating these beliefs and codes on an organization, self, and others.
	Organizational effectiveness	Adapting to the organization's goals, values, culture, and traditional modes of operation.
Resources	Time	Selecting relevant, goal-related activities, ranking them in order of importance, allocating time, and understanding, preparing, and following schedules.
	Money	Using or preparing budgets, making forecasts, keeping records, and making adjustments to meet objectives.
	Material and facilities	Acquiring, storing, and using materials space efficiently.
	Human resources	Assessing skills and distributing work accordingly, evaluating performance and providing feedback.
Interpersonal Skills	Teamwork	Working cooperatively with others to reach a common goal.
	Coaching	Helping others learn new skills.
	Leadership	Communicating ideas to justify position, accepting responsibility for others, and encouraging, persuading, convincing, or otherwise motivating an individual or group.
	Negotiation	Resolving conflict between two or more individuals through discussion and compromise.
	Customer service	Working and communicating with customers to satisfy their expectations.
	Cultural diversity	Working well with men and women and with a variety of ethnic, social, or educational backgrounds.
Information	Acquisition and evaluation	Identifying need for data, obtaining it from existing sources or creating it, and evaluating its relevance and accuracy.
	Organization and storage	Organizing, processing, and maintaining written or computerized records and other forms of information in a systematic way.
	Interpretation	Selecting and analyzing information and communicating the results to others.
	Processing	Using computers to acquire, organize, analyze, and communicate information.

SCANS Foundation Skills and Competencies

Skill Groups	Sub Skills	Definitions
Systems	Interrelationships	Knowing how social, organizational, and technological systems work and operate effectively.
	Monitoring	Distinguishing trends, predicting impact of actions on system operations, diagnosing deviations in systems' performance and correcting malfunctions.
	Modification and design	Making suggestions to modify existing systems to improve products or services, and developing new or alternative systems.
Technology	Selection	Choosing procedures, tools, or equipment including computers and related technologies.
	Application	Demonstrating proper procedures for setting up and operating equipment.
	Maintenance and troubleshooting	Preventing, identifying, or solving problems with equipment, including computers and other technologies.

Domestic Refrigerator, Freezer, and Window Air Conditioner Service

Competency Profile

Name: ______________________________

Directions: Evaluate the student using the rating scale below. Write the appropriate number to indicate the degree of competency achieved. The descriptions associated with each of the numbers focuses on a level of student performance for each of the tasks listed. The written test scoreline is provided for optional teacher use. It may not be applicable in all cases.

Option A

Rating scale:
4 – Skilled – Can perform job with no additional training
3 – Moderately Skilled – Has performed job during training program; limited additional training may be required.
2 – Limited Skill – Has performed job during training program; additional training is required to develop skill.
1 – Unskilled – Is familiar with process, but is unable to perform job.
0 – No Exposure – No information or practice provided during training program, complete training required.
NA – Non-applicable.

Option B

Yes – Can perform with no additional training
No – Is unable to perform satisfactorily

Unit 1: Service Fundamentals

_______ 1. Install a refrigerator.
_______ 2. Adjust a refrigerator door.
_______ 3. Switch refrigerator door orientation.
_______ 4. ______________________________

_______Written Test Score

Unit 2: Mechanical Components and Functions

_______ 1. Attach a manifold gauge set to a refrigerator or freezer using a line tap valve.
_______ 2. Access a refrigerator or freezer with a service valve adapter.
_______ 3. ______________________________

_______Written Test Score

Unit 3: Electrical Components and Control Devices

_______ 1. Identify heater circuits on a schematic.
_______ 2. Identify controls on a schematic.
_______ 3. Replace a temperature control.
_______ 4. Replace defrost heater.
_______ 5. ______________________________

_______Written Test Score

Unit 4: Refrigerator and Freezer Service

_______ 1. Use a troubleshooting guide to find possible causes of customer complaints.
_______ 2. Diagnose circuit problems using a schematic.
_______ 3. Select filter-driers for given applications.
_______ 4. Select compressors for given applications.
_______ 5. Perform maintenance on a refrigerator or freezer.
_______ 6. Remove and replace breaker trim.
_______ 7. Troubleshoot selected problems in a refrigerator or freezer.
_______ 8. Check the efficiency of a compressor.
_______ 9. Replace an evaporator fan motor.
_______ 10. Replace a condenser fan motor.
_______ 11. Repair a leak in an aluminum evaporator using paste epoxy.
_______ 12. Repair a leak in an aluminum evaporator using a pre-mixed, two-part epoxy stick.
_______ 13. Repair a hole in an aluminum evaporator by brazing.
_______ 14. Replace an aluminum-to-aluminum or an aluminum-to-copper swage joint.
_______ 15. Replace a liquid-line filter.
_______ 16. Charge a small, refrigerated appliance using a charging cylinder.
_______ 17. Charge a small, refrigerated appliance using charging scales.
_______ 18. Service a capillary tube.
_______ 19. Replace a compressor.
_______ 20. ____

_______ Written Test Score

Unit 5: Domestic Ice Maker Service

_______ 1. Use troubleshooting guides to solve domestic ice maker problems.
_______ 2. Install a water line to a refrigerator equipped with an ice maker.
_______ 3. Disassemble and clean a water fill valve.
_______ 4. Replace a thermostat in a crescent-shaped cube ice maker.
_______ 5. Replace the mold heater in a crescent-shaped cube ice maker.
_______ 6. Replace the mold, seal, bearing, and retainer in a five-cavity ice maker.
_______ 7. Adjust the water valve switch in a flex-tray ice maker.
_______ 8. ____

_______ Written Test Score

Unit 6: Window Air Conditioner Service

_______ 1. Use a troubleshooting chart to find causes of customer complaints.
_______ 2. Install a window air conditioner.
_______ 3. Clean a window air conditioner.
_______ 4. Replace a fan motor.
_______ 5. Replace a fan motor.
_______ 6. Troubleshoot a control switch.
_______ 7. Replace a liquid line filter-drier.
_______ 8. Charge a window air conditioner using a charging cylinder.
_______ 9. Charge a window air conditioner using charging scales.

Competency Profile

________10. Evaluate a window air conditioner charge using a superheat charging chart.
________11. Service a capillary tube.
________12. Replace a compressor.
________13. ____

________Written Test Score

COMMENTS: ____

____

____

____

____

Evaluator: __________________________ Date: __________________

Permission to duplicate this profile is granted.

Domestic Refrigerator, Freezer, and Window Air Conditioner Service

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 1: Service Fundamentals

1. Terms and definitions
2. Guidelines for domestic refrigeration
3. Refrigerator and freezer design objectives
4. Compartment design objectives
5. Components of a refrigerator and their functions
6. Considerations for in-home refrigeration service
7. Data plate information and where to find it
8. Troubleshooting common problems
9. Transporting a refrigerated appliance
10. Installing or reinstalling a refrigerator
11. Disposing of small, refrigerated appliances
12. Looking beyond the service call

13. Install a refrigerator. (Job Sheet 1)
14. Adjust a refrigerator door. (Job Sheet 2)
15. Switch refrigerator door orientation. (Job Sheet 3)

Unit 2: Mechanical Components and Functions

1. Terms and definitions
2. Mechanical components in a refrigerator or freezer
3. Compressors
4. Condensers
5. Evaporators
6. Metering devices
7. Accessories
8. Operating characteristics of refrigerators and freezers

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 2: Mechanical Components and Functions (cont.)

9. Procedures for checking system pressures
10. Procedures for checking system temperatures
11. Evaluating system operations

12. Attach a manifold gauge set to a refrigerator or freezer using a line tap valve. (Job Sheet 1)
13. Access a refrigerator or freezer with a service valve adapter. (Job Sheet 2)

Unit 3: Electrical Components and Control Devices

1. Terms and definitions
2. Purposes of electrical components and control devices
3. Temperature controls
4. Start components
5. Air flow
6. Controls and conditions for major compartments
7. Controls and conditions for compartments within compartments
8. Controlling frost and ice accumulation
9. Electric defrost
10. Hot gas defrost

11. Identify heater circuits on a schematic. (Assignment Sheet 1)
12. Identify controls on a schematic. (Assignment Sheet 2)
13. Replace a temperature control. (Job Sheet 1)
14. Replace a defrost heater. (Job Sheet 2)

Unit 4: Refrigerator and Freezer Service

1. Terms and definitions
2. General procedure for service
3. Gathering information about the equipment and type of service
4. Evaluating equipment condition
5. Investigating problems
6. Determining actual causes of problems
7. Servicing appliance cabinets
8. Servicing electrical components

Instructional/Task Analysis

Unit 4: Refrigerator and Freezer Service (cont.)

Related Information: What the Student Should Know

9. Replacing electrical components
10. Servicing refrigeration components
11. Repairing refrigerant leaks
12. Safety while replacing refrigeration components
13. Servicing capillary tubes
14. Replacing compressors

Application: What the Student Should Be Able to Do

15. Use a troubleshooting guide to find possible causes of customer complaints. (Assignment Sheet 1)
16. Diagnose circuit problems using a schematic. (Assignment Sheet 2)
17. Select filter-driers for given applications. (Assignment Sheet 3)
18. Select compressors for given applications. (Assignment Sheet 4)
19. Perform maintenance on a refrigerator or freezer. (Job Sheet 1)
20. Remove and replace breaker trim. (Job Sheet 2)
21. Troubleshoot selected problems in a refrigerator or freezer. (Job Sheet 3)
22. Check the efficiency of a compressor. (Job Sheet 4)
23. Replace an evaporator fan motor. (Job Sheet 5)
24. Replace a condenser fan motor. (Job Sheet 6)
25. Install a process tube adapter on a refrigerator or freezer. (Job Sheet 7)
26. Repair a leak in an aluminum evaporator using paste epoxy. (Job Sheet 8)
27. Repair a leak in an aluminum evaporator using a pre-mixed, two-part epoxy stick. (Job Sheet 9)
28. Repair a hole in an aluminum evaporator by brazing. (Job Sheet 10)
29. Replace an aluminum-to-aluminum or aluminum-to-copper swage joint. (Job Sheet 11)
30. Replace a liquid-line filter. (Job Sheet 12)

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 4: Refrigerator and Freezer Service (cont.)

31. Charge a small, refrigerated appliance using a charging cylinder. (Job Sheet 13)
32. Charge a small, refrigerated appliance using charging scales. (Job Sheet 14)
33. Service a capillary tube. (Job Sheet 15)
34. Replace a compressor. (Job Sheet 16)

Unit 5: Domestic Ice Maker Service

1. Terms and definitions
2. Basic types of domestic refrigerator ice makers
3. How a crescent-shaped ice maker works
4. How a five-cavity ice-maker works
5. How a flex-tray ice maker works
6. Storing and dispensing ice
7. Ice maker water supply and control devices
8. Parts of a crescent-shaped cube ice maker
9. Parts of a five-cavity ice maker
10. Troubleshooting ice makers
11. Ice maker service

12. Use troubleshooting guides to solve domestic ice maker problems. (Assignment Sheet 1)
13. Install a water line to a refrigerator equipped with an ice maker. (Job Sheet 1)
14. Disassemble and clean a water fill valve. (Job Sheet 2)
15. Replace a thermostat in a crescent-shaped cube ice maker. (Job Sheet 3)
16. Replace the mold heater in a crescent-shaped cube ice maker. (Job Sheet 4)
17. Replace the mold, seal, bearing, and retainer in a five-cavity ice maker. (Job Sheet 5)
18. Adjust the water valve switch in a flex-tray ice maker. (Job Sheet 7)

Unit 6: Window Air Conditioner Service

1. Terms and definitions
2. The objectives of window air conditioning
3. Mechanical components of a window air conditioner
4. Electrical components of a window air conditioner
5. Window air conditioner cabinet parts
6. Window air conditioner data plates

Instructional/Task Analysis

Unit 6: Window Air Conditioner Service (cont.)

Related Information: What the Student Should Know

7. Compressor data plates
8. Electrical requirements for window air conditioner installation
9. Windows and other openings
10. Installing a window air conditioner
11. Evaluating equipment condition
12. Investigating possible causes of problems
13. Determining actual causes of problems
14. Servicing electrical components
15. Replacing electrical components
16. Servicing refrigeration components
17. Safety while replacing refrigeration components
18. Servicing capillary tubes

Application: What the Student Should Be Able to Do

19. Use a troubleshooting chart to find causes of customer complaints. (Assignment Sheet 1)
20. Install a window air conditioner. (Job Sheet 1)
21. Clean a window air conditioner. (Job Sheet 2)
22. Replace a fan motor. (Job Sheet 3)
23. Install a hard start kit. (Job Sheet 4)
24. Troubleshoot a control switch. (Job Sheet 5)
25. Replace a liquid line filter-drier. (Job Sheet 6)
26. Charge a window air conditioner using a charging cylinder. (Job Sheet 7)
27. Charge a window air conditioner using charging scales. (Job Sheet 8)
28. Evaluate a window air conditioner charge using a superheat charging chart. (Job Sheet 9)
29. Service a capillary tube. (Job Sheet 10)
30. Replace a compressor. (Job Sheet 11)

SCANS Foundation Skills for
Domestic, Refrigerator, Freezer, and Window Air Conditioner Service

Task	Skill Group or Competency	Sub Skill or Competency	Description
Unit 1: Service Fundamentals			
Install a refrigerator. (J.S. 1)	Technology competency	Application	Demonstrates proper procedure for evaluating area conditions and installing a refrigerator
Adjust a refrigerator door. (J.S. 2)	Technology competency	Application	Demonstrates ability to adjust a refrigerator door to ensure a tight seal
Switch refrigerator door opening hardware. (J.S. 3)	Technology competency	Application	Demonstrates ability to switch the side on which a refrigerator door opens
Unit 2: Mechanical Components and Functions			
Attach a manifold gauge set to a refrigerator or freezer using a line tape valve. (J.S. 1)	Technology competency	Application	Demonstrates proper procedure for evaluating area conditions and installing a refrigerator
Access a refrigerator or freezer with a service valve adapter. (J.S. 2)	Technology competency	Application	Demonstrates proper procedure for evaluating area conditions and installing a refrigerator
Unit 3: Electrical Components and Control Devices			
Identify heater circuits on a schematic. (J.S. 1)	Basic skills	Science	Interprets lines and symbols to identify a circuit on a schematic
Identify controls on a schematic. (J.S. 2)	Basic skills	Science	Interprets lines and symbols to identify a control element on a schematic
Replace a temperature control. (J.S. 3)	Technology competency	Application	Demonstrates ability to follow a procedure for replacing an electrical component
Replace a defrost heater. (J.S. 4)	Technology competency	Application	Demonstrates ability to follow a procedure for replacing an electrical component
Unit 4: Refrigerator and Freezer Service			
Use a troubleshooting guide to find possible causes of customer complaints. (A.S. 1)	Thinking skills	Problem solving	Recognizes and defines problems and plans a troubleshooting routine
Diagnose circuit problems using a schematic. (A.S. 2)	Basic skills	Science	Interprets lines and symbols to isolate trouble spots indicated in a schematic
Select filter-driers for given applications. (A.S. 3)	Basic skills	Reading	Interprets manufacturer's product specifications to determine proper replacement filter-driers
Select compressors for given applications. (A.S. 4)	Basic skills	Reading	Interprets manufacturer's product specifications to determine proper replacement compressors
Perform maintenance on a refrigerator or freezer. (J.S. 1)	Technology competency	Application	Demonstrates the ability to use proper tools and materials to perform maintenance activities

Task	Skill Group or Competency	Sub Skill or Competency	Description
Unit 4: Refrigerator and Freezer Service			
Remove and replace breaker trim. (J.S. 2)	Technical competency	Application	Demonstrates ability to follow a procedure for replacing an electrical component
Troubleshoot selected problems in a refrigerator or freezer. (J.S. 3)	Thinking skills	Problem solving	Recognizes and defines problems typical to refrigerators or freezers
Check the efficiency of a compressor. (J.S. 4)	Technical competency	Application	Uses test instruments to isolate compressor problems
	Thinking skills	Problem solving	Recognizes and defines problems
Replace an evaporator fan motor. (J.S. 5)	Technical competency	Application	Demonstrates the ability to replace an electrical component
Replace a condenser fan motor. (J.S. 6)	Technical competency	Application	Demonstrates the ability to replace an electrical component
Install a process tube adapter on a refrigerator or freezer. (J.S. 7)	Technical competency	Application	Demonstrates the ability to install a refrigeration component
Repair a leak in an aluminum evaporator using paste epoxy. (J.S. 8)	Technical competency	Application	Demonstrates the ability to complete a difficult repair on a refrigeration component
Repair a leak in an aluminum evaporator using a pre-mixed, two-part epoxy stick. (J.S. 9)	Technical competency	Application	Demonstrates the ability to complete a difficult repair on a refrigeration component
Repair a leak in an aluminum evaporator by brazing. (J.S. 10)	Technical competency	Application	Demonstrates the ability to complete a difficult repair without damaging a refrigeration component
Replace an aluminum-to-aluminum or an aluminum-to copper swage joint. (J.S. 11)	Technical competency	Application	Demonstrates the ability to join similar or dissimilar metals
Replace a liquid line filter. (J.S. 12)	Technical competency	Application	Demonstrates the ability to install a refrigeration component
Charge a small, refrigerated appliance using a charging cylinder. (J.S. 13)	Technical competency	Application	Demonstrates the ability to use a charging chart to charge a system to manufacturer's specifications
Charge a small, refrigerated appliance using charging scales. (J.S. 14)	Technical competency	Application	Demonstrates the ability to use a charging chart to charge a system to manufacturer's specifications
Service a capillary tube. (J.S. 15)	Technical competency	Application	Demonstrates the ability to clean, service, and/or replace a refrigeration component
Replace a compressor. (J.S. 16)	Technical competency	Application	Demonstrates the ability to properly remove and old compressor and manage sensitive system functions while installing a new compressor

SCANS Foundation Skills

Task	Skill Group or Competency	Sub Skill or Competency	Description
Unit 5: Domestic Ice Maker Service			
Use troubleshooting guides to solve domestic ice maker problems. (A.S. 1)	Thinking skills	Problem solving	Recognizes and defines problems and plans a troubleshooting routine
Install a water line to a refrigerator equipped with an ice maker. (J.S. 1)	Technical competency	Application	Demonstrates the ability to access a water supply and install water service to a refrigerator
Disassemble and clean a water fill valve. (J.S. 2)	Technical competency	Application	Demonstrates the ability to service an ice maker component
Replace a thermostat in a crescent-shaped cube ice maker. (J.S. 3)	Technical competency	Application	Demonstrates the ability to troubleshoot and replace an ice maker electrical component
Replace the mold heater in a crescent-shaped cube ice maker. (J.S. 4)	Technical competency	Application	Demonstrates the ability to remove and replace an ice maker electrical component
Replace the mold, seal, bearing, and retainer in a five-cavity ice maker. (J.S. 5)	Technical competency	Application	Demonstrates the ability to use special tools to complete major ice maker service
Adjust the water valve switch in a flex-tray ice maker. (J.S. 6)	Technical competency	Application	Demonstrates the ability to perform ice maker component service requiring the use of a graduated cylinder to measure water in cc's
	Basic skills	Science	
Unit 6: Window Air Conditioner Service			
Use a troubleshooting chart to find causes of customer complaints. (A.S. 1)	Thinking skills	Problem solving	Recognizes and defines problems and plans a troubleshooting routine
Install a window air conditioner. (J.S. 1)	Technical competency	Application	Demonstrates the ability to properly prepare space, evaluate electrical service, and install a window air conditioner
	Basic skills	Science	
Clean a window air conditioner. (J.S. 2)	Technical competency	Application	Demonstrates the ability to disassemble, clean, and reassemble a window air conditioner
Replace a fan motor. (J.S. 3)	Technical competency	Application	Demonstrates the ability to select and install a replacement fan motor
Install a hard start kit. (J.S. 4)	Technical competency	Application	Demonstrates the ability to work with electrical elements to install a starting component
Troubleshoot a control switch. (J.S. 5)	Technical competency	Application	Demonstrates the ability to follow a troubleshooting routine and evaluate conditions of an electrical component
	Basic skills	Science	

Task	Skill Group or Competency	Sub Skill or Competency	Description
Unit 6: Window Air Conditioner Service (cont.)			
Replace liquid line filter-drier. (J.S. 6)	Technical competency	Application	Demonstrates the ability to prepare a system and safely install an electrical component
Charge a window air conditioner using a charging cylinder. (J.S. 7)	Technical competency	Application	Demonstrates the ability to use a charging chart and appropriate equipment to charge a system to manufacturer's specifications
Charge a window air conditioner using charging scales. (J.S. 8)	Technical competency	Application	Demonstrates the ability to use a charging chart and appropriate equipment to charge a system to manufacturer's specifications
Evaluate a window air conditioner using a superheat charging chart. (J.S. 9)	Technical competency	Application	Demonstrates the ability to access a system and interpret pressure/temperature readings to evaluate system performance
	Basic skills	Science	
Service a capillary tube. (J.S. 10)	Technical competency	Application	Demonstrates the ability to clean, service, and/or replace a refrigeration component
Replace a compressor. (J.S. 11)	Technical competency	Application	Demonstrates the ability to manage sensitive system functions while properly removing and replacing a compressor

Domestic Refrigerator, Freezer, and Window Air Conditioner Service

Tools, Equipment, and Materials List

Hand Tools

Refrigeration technician's handtools
(See VICA Suggested STudent Tool Kit)
Vacuum cleaner
Cleaning brushes
Slim taper file
Slide caliper
Capillary tube gauge or drill set
Pinch-off tool
Soldering/brazing torch
Soldering/brazing rod w/flux
Hand-held drier
Test cord

System Service Equipment

Recovery machine

Recovery/recycling machine
Filters/filter-driers
Vacuum pump
System access valves or adapters
Process tube adapter

Dry nitrogen cylinder w/regulator
Charging cylinder
Charging scales

Instruments

Ammeter or wattmeter
Ohmmeter
Remote bulb thermometer (electric or electronic)
Component analyzer (optional)

Replacement Components

Condenser fan motor
Evaporator fan motor
Compressor
Assortment of capillary tubes
Defrost heater w/literature

Miscellaneous Supplies

Replacement breaker trim
Replacement insulation
Wood block, 6" x 4" x 1"
Bucket
Clean shop rags

Special Materials/Supplies for Ice Maker Service

Copper tubing for water line
Water line saddle valve
3/8" drill with 5/32" and 3/8" drill bits
Vinegar for cleaning
Crescent-shaped cube ice maker
Thermostat for crescent-shaped ice maker
Mold heater for crescent-shaped ice maker
Mold, seal, bearing, and retainer for five-cavity ice maker
Seal remover (Robinair #14368 or equivalent)
Seal assembly
Retainer remover
Silicon lubricant
Retainer washer installation tool (Robinair #14173 or equivalent)
Flex-tray ice maker

Special Materials/Supplies for Window Air Conditioner Service

Caulking gun and caulking compound
Level
Hand saw
Plastic bag
Water hose w/spray nozzle
Cleaning solution or coil cleaner
Rubber gloves
Replacement fan motor w/literature
Start capacitor w/bleed resistor
Potential relay
14-gauge strand wire
Wire connectors
Side cutters and crimping tool
Ammeter and ohmmeter
Control switch
Masking tape
Marker
Sweat-type filter-drier
Extra charging hose
Thermometer w/remote sensing bulb
Tape or velcro to secure sensing bulb
Pipe insulation to wrap sensing bulb
Line tap valve
Service valve adapter
Replacement temperature control w/line temperature
Temperature recorder

Note: For VICA's Suggested Student Tool Kit, see next page.

Domestic Refrigerator, Freezer, and Window Air Conditioner Service

Tools, Equipment, and Materials List

Suggested Student Tool Kit

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- Toolbox with lock and nametag
- Rule (12")
- Measuring tape (12")
- Electrical tape
- Electrical wire nuts
- Electrical wire terminals
- VOM/analog-digital meter
- Flat-tip screwdrivers (assortment of four sizes)
- Phillips-head screwdrivers (assortment of four sizes)
- Nutdrivers (set of seven)
- Electrician's knife
- Longnose pliers (6")
- Diagonal pliers
- Wirecutters (6")
- Slipjoint pliers (6")
- Adjustable wrench (8" or 10")
- Locking pliers (6")
- Arc-joint pliers (8" or 10")
- Ball pen hammer
- Soldering iron
- Crimping tool
- Drive socket set with extension (1/4")
- Driver socket set with extension (3/8")
- Hacksaw/extra blades
- Pocket thermometer
- Mercury thermometer
- Safety glasses
- Torch striker
- Gauge manifold set with quick connect hose
- Flaring kit
- Swaging kit
- Clamp-on ammeter
- Allen wrench set

The VICA Student Tool Kit contains some items not specifically needed for *Domestic Refrigerator, Freezer, and Window Air Conditioner Service*. However, the complete kit is essential for students working with other MAVCC ACR texts.

Domestic Refrigerator, Freezer,
and
Window Air Conditioner Service

References

Althouse, Andrew D. et al. *Modern Refrigeration and Air Conditioning.* South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.

Armstrong Value Parts Catalog, spring and summer 1993. Wichita, KS: Washer Specialties Co., 1993.

Sporlan Catch-All® Liquid Line and Suction Line Filter-Driers plus AK-1 and AK-3 Acid Test Kits, Bulletin 40-10. St. Louis, MO: Sporlan Valve Company, 1991.

The Air Conditioning, Heating, and Refrigeration News HVAC/R Source Guide. Troy, MI: Business News Publishing Company, 1993.

Valves and Accessories for Refrigeration and Air Conditioning Applications, Catalog 111C. Melrose Park, IL: Henry Valve Company, 1993.

Wantiez, Gary W. *Air Conditioning and Refrigeration, Domestic Refrigeration.* Stillwater, OK: The Mid-America Vocational Curriculum Consortium, 1984.

Whitman, William C. and William M. Johnson. *Refrigeration & Air Conditioning Technology, 2nd ed.* Albany, NY: Delmar Publishers, Inc., 1991.

Wholesale Net Price Book, Fall/Winter 1995. Wichita, KS: Johnstone Supply, 1995.

Service Fundamentals
Unit 1

Objective Sheet

Unit Objective

After completing this unit, the student should be able to install a refrigerator, adjust a refrigerator door, and switch a refrigerator door orientation. The student should demonstrate these competencies by completing the job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to service fundamentals for domestic refrigeration with their correct definitions.
2. Correct statements about general guidelines for domestic refrigeration service.
3. Solve problems about refrigerator and freezer design objectives.
4. Complete statements about compartment design objectives.
5. Match components of a refrigerator with their functions.
6. Solve problems about considerations for in-home refrigeration service.
7. Select true statements about data plate information and where to find it.
8. Complete statements about troubleshooting common problems.
9. Select true statements about considerations for transporting a refrigerated appliance.
10. Solve problems about installing or reinstalling a refrigerator.
11. Select true statements about disposing of small, refrigerated appliances.
12. Complete statements about looking beyond the service call.
13. Install a refrigerator. (Job Sheet 1)
14. Adjust a refrigerator door. (Job Sheet 2)
15. Switch refrigerator door orientation. (Job Sheet 3)

Service Fundamentals
Unit 1

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction or individual learning activities. Study the specific objectives to determine the order in which you will present the objectives.
2. Review Teaching Suggestions section that follows. Plan for classroom activities.
3. Plan enrichment of exceptional students as well as accommodation of special needs students.
4. Add graphic materials or overhead transparencies as needed.
5. Develop teaching plan. Adjust for different learning styles.
6. Make copies of the Unit Evaluation Form.

Delivery and Application

7. Provide students with unit of instruction.
8. Discuss unit and specific objectives.
9. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic skills when applicable.
10. Discuss and demonstrate the procedures in the job sheets. Review criteria for evaluation of the activity.

Evaluation

11. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
12. Make copies of written test. Add or modify test items as needed.
13. Give written test.
14. Compile job sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignment or job sheets.
15. Reteach and retest as required.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the Teaching Suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

1. Find an ACR service firm or an individual firm in your area who specializes in servicing and repairing refrigerated appliances. Invite them to share with the class some of the unique technical skills domestic service requires, but have the speaker especially address the people skills required for the job. Skill areas: **Basic skills, listening.**

2. Invite the same or similar person as referenced in item 1 to talk to the class about the importance of new EPA regulations with respect to residential service, especially requirements about disposal of nonoperating refrigerators or freezers. Skill areas: **Thinking skills, seeing things in the mind's eye.**

3. Group students into teams and then assign each team to visit a local company or individual's shop to learn about preparation required for an in-home service call. Have students manage the information by subject matter, paper work required, general and specific equipment required, vehicle selection, and importance of looking sharp and clean when making a call. Have students prepare reports to share with the class and make the reports a part of discussion for Objective 6. Skill areas: **Interpersonal skills, teamwork.**

Resources Used in Developing This Unit

1. *The Air Conditioning, Heating and Refrigeration News HVAC/R Source Guide*. Troy, MI: Business News Publishing Company, 1993.

2. Wantiez, Gary W. *Air Conditioning and Refrigeration, Domestic Refrigeration*. Stillwater, OK: The Mid-America Vocational Curriculum Consortium, 1984.

Suggested Supplemental Resources

The Vocational Industrial Clubs of America Professional Development Program provides students with opportunities to advance their interpersonal skills as they train for the workplace. The PDP preliminary begins with a VICA Student Workbook which introduces students to the benefits of the VICA program in general and VICA's nationwide student activities.

The Professional Development Program expands on basic VICA goals and is filled with extracurricular activities designed to encourage student participation in community affairs, and goal-oriented personal improvement activities.

The PDP itself features a Student Starter Kit and moves through a series of student workbooks starting with Level 1 and advancing through Level 5. A final workbook is dedicated to the Post Professional Development Program.

The PDP also contains special materials for instructors. These instructor materials include the basic *VICA Instructor's Manual*, the *Part I Instructor's Guide*, and the *Part II Instructor's Guide*. Part 1 features instructor aids for presenting the *Starter Kit* and the levels 1 and 2 of the PDP along with special needs adaptations. Part II features materials for levels 3 and 4 of the PDP along with the post PDP and special needs adaptations.

Suggested Activities

Be sure to read Teacher Supplement 1 in this unit of instruction to get a better feel of what the PDP is really all about and why air conditioning programs in particular can benefit from the program. Schools can include purchases for several programs at once and enjoy a volume discount. For information, call VICA toll-free at 1-800-321-8422. If you prefer to write, the address is:

VICA
P.O. Box 3000
Leesburg, VA 22075

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student' product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

Service Fundamentals
Unit 1

Answers to Written Test

1. a. 5
   b. 9
   c. 3
   d. 6
   e. 1
   f. 4
   g. 8
   h. 10
   i. 2
   j. 7

2. a. life styles
   b. usually
   c. troubleshooting and repair
   d. rapidly
   e. bulk
   f. losing
   g. as quickly as possible

3. a. Practice proper packaging
   b. Smaller ice crystals are less damaging to food

4. a. some
   b. air-tight
   c. freezer
   d. slightly
   e. table-ready
   f. internal
   g. top
   h. freezer
   i. evaporator

5. a. 9
   b. 5
   c. 2
   d. 7
   e. 3
   f. 6
   g. 1
   h. 8
   i. 4

6. a. 2)
   b. 2)
   c. 2)
   d. 2)

7. a, b, c, d

8. a. shop repair
   b. installed
   c. condenser, condenser
   d. adjustment, seals
   e. internal
   f. external
   g. defrost
   h. water disposal
   i. humidity, humidity
   j. refrigerator, freezer
   k. thermostat, damper
   l. complex, refrigeration

Answers to Written Test

9. a, b, c, e, f, g

10.
    a. Make a hook-up coil from new tubing.
    b. Because heat from running components will rise.
    c. Recommend that the refrigerator be moved to a different location away from the heat or shielded.

11. a, d, e, f

12.
    a. Recommend a new refrigerator or an extended service contract.
    b. Recommend that the door opening hardware be switched to the other side, if the refrigerator has the predrilled holes required for the change.
    c. Recommend a new refrigerator with ice/cold water service in the door; it will save energy.

Service Fundamentals
Unit 1

Written Test

Name ______________________ Date ____________ Score ____________

1. Match the terms on the right with their correct definitions.

______ a. A usually self contained, electrically operated device used for household purposes; the term is used in a variety of ways by industry, federal and state agencies, and utility companies

______ b. A wheeled dolly or hand truck designed especially for transporting appliances; it has wide tie-down straps that tighten with a ratchet and usually has rollers on the back to facilitate movement up and down stairs

______ c. A space separated by walls and doors or drawers from ambient conditions or other compartment conditions

______ d. A tag affixed to an appliance to provide a permanent service reference for information about electrical characteristics and refrigerant charge

______ e. Self-contained refrigerators, freezers, and other refrigerated home appliances that can be unplugged and readily transported to a service facility for repair

______ f. The ratio of energy output to energy input, a way of expressing how much energy is required to produce a given output; it helps manufacturers provide customers with an estimate of the annual cost of operating an appliance

______ g. A type of freezer designed to keep food storage areas free of frost and ice build-up to avoid the need for defrosting

______ h. Procedures performed at scheduled intervals to check and service components or conditions of a refrigerated appliance in order to minimize the need for repairs and maximize system performance

______ i. Performing maintenance, troubleshooting, and/or repairs

______ j. A systematic approach to determine the cause(s) of component malfunctions or general system problems

1. Domestic refrigeration
2. Service
3. Compartment
4. EER
5. Appliance
6. Data plate
7. Troubleshooting
8. Frost free
9. Appliance dolly
10. Maintenance

Written Test

2. Complete statements about general guidelines for domestic refrigeration service. Circle the material that best completes each of the following statements.

   a. Refrigerator and freezer problems pose special concerns for homeowners because they are an essential part of modern (**food services**) (**life styles**) that demand TV dinners at any time of the day and frozen strawberries for mid-winter desserts.

   b. The modern refrigerator is (**usually**) (**always**) a refrigerator/freezer with the freezer above or below the fresh food compartment, or a side-by-side model with an upright freezer built into the system right beside the refrigerator.

   c. Many side-by-side models have in-door service for ice or cold water or both, and these components require special skills for (**troubleshooting and repair**) (**users and installers**).

   d. Problems posed by refrigerator/freezers involve more than just the need for repairs; the customer frequently will have both frozen and chilled foods that could (**rapidly**) (**slowly**) spoil if they are not restored to a proper environment.

   e. Chest and upright freezers pose special problems because they frequently contain (**bulk**) (**packaged**) quantities of meats or seasonal fruits and vegetables that are packaged during the growing season and frozen for year-round use.

   f. In all cases, a refrigerator or freezer that quits working causes special customer concern for both the inconvenience and the expense of (**repackaging**) (**losing**) food or paying for enough ice to provide temporary storage in an ice chest.

   g. Whether repairs are made in the home or in the shop, refrigerators and freezers need to be repaired and returned to service (**within 24 hours**) (**as quickly as possible**) to alleviate concerns of anxious customers.

3. Solve problems about refrigerator and freezer design objectives. Write in the information that best solves each of the following problems.

   a. A customer complains that food in a refrigerator is drying out. As a technician, you suggest the customer begin using compartments properly to help keep food better, but the drying out problem can also be solved if the customer will:

   ____

   ____

   b. A customer complains that frozen foods have ice crystals in them and don't look good after they thaw out, so you advise the customer to place the foods at a colder location within a compartment because the foods will freeze faster and smaller ice crystals will form. The customer doesn't understand about the small ice crystals, so you should explain that:

   ____

   ____

Written Test

4. Complete statements about compartment design objectives. Circle the material that best completes each of the following statements.

   a. To meet the design objectives of keeping food safe and fresh, food placed in a refrigerator or freezer requires (**some**) (**much**) preparation and special storage.

   b. A fresh food compartment keeps food best when the food is wrapped in foil or Saran wrap or enclosed in (**air-tight**) (**water-filled**) containers.

   c. A freezer compartment keeps food best when the food is wrapped in (**wax**) (**freezer**) paper or sealed in moisture-proof containers.

   d. A butter keeper compartment isolates butter from the fresh food environment to keep it (**slightly**) (**quite a bit**) warmer and easier to spread, but only if the butter compartment door is kept closed.

   e. A crisper compartment at the bottom of the fresh food compartment isolates vegetables to keep them from drying out, but vegetables need to be cleaned and (**table-ready**) (**wrapped**) before they go into the crisper.

   f. An egg keeper uses molded indentations in a tray or door to protect eggs; indentations are designed especially to store eggs small end down to protect them from (**internal**) (**every kind of**) damage.

   g. A meat keeper close to the (**top**) (**bottom**) of the fresh food compartment where cold air first enters keeps meat or other food slightly cooler so it stays fresh longer.

   h. A (**freezer**) (**refrigerator**) compartment may have a bin or area to store ice made in ice trays or produced with an automatic ice maker.

   i. A fast-freeze shelf or area may be located near the ice storage to freeze food quickly when it is first placed in the freezer because the area is at the beginning of the (**evaporator**) (**freezer compartment**) or where cold air first enters the compartment.

5. Match components of a refrigerator with their functions. Place the number beside the component name in the blank beside the description of its function.

_______ a. Plastic trim that covers the space between the cabinet and the liner of a refrigerator

_______ b. Provides access to interior refrigerated compartments

_______ c. Provides a covering for in-door insulation and is formed with shelving or small storage spaces for holding food stuffs

_______ d. A resilient, flexible material used around a refrigerator door to provide a leak-proof seal

_______ e. Provides a covering for in-cabinet insulation and supports in-door shelving while providing a smooth, easy-to-clean interior

1. Mullion
2. Door liner
3. Inner liner
4. Toe plate
5. Door handle
6. Insulation
7. Gasket
8. Outer liner
9. Breaker strip

_______ f. A barrier in exterior walls of an appliance foamed or fitted into place to retain interior cold and reject exteriors heat

_______ g. A divider that separates a freezer compartment from a refrigerator compartment

_______ h. Provides a covering for an entire refrigerated appliance, and is frequently enameled for easy cleaning, extended wear, and cosmetic appeal

_______ i. A protective barrier fitted at the bottom of the appliance to keep things from getting underneath while letting air through

6. Solve problems about considerations for in-home refrigeration service. Write in the information that best solves each of the following problems.

   a. A customer offers a technician coffee and a doughnut when the technician shows up for a service call. The technician should:

      1) Accept the offer graciously and get on with the call as soon as possible.

      2) Politely refuse the offer and remind the customer that all time spent on a service call is charged to the customer.

   b. You show up on a service call and start looking over the equipment based on the work order given you by your supervisor. You should:

      1) Continue troubleshooting until you find any problems listed on the work order.

      2) Talk to the customer about the problem; chances are the work order was taken over the phone and addresses general, not specific problems.

   c. You know you're going to be about 15 minutes late to a scheduled in-home service call. You should:

      1) Make sure you are no more than 15 minutes late, and if the time for your call goes past that 15 minute mark, call the customer and explain what is happening.

      2) Call the customer to explain why you will be late and indicate how late you will be so the customer can reschedule the appointment or rearrange a schedule, if needed, to still be there for your call.

   d. You have completed a service call and start placing old parts into your tool kit so you can take them back to the office to properly dispose of them. You should:

      1) Tell the customer that the parts are no good and that you will take the responsibility of properly disposing of them.

      2) Show the old parts to the customer, explain why they no longer work, and explain the charges for the parts.

Written Test

7. Select true statements about data plate information and where to find it. Place an "X" beside each true statement.

_______ a. Information on a data plate is critical for the proper service of refrigerated appliances because of the significant information the plate contains.

_______ b. The data plate should indicate a brand name, a model number, and a serial number, items required for hunting parts and service literature.

_______ c. The data plate should also indicate the voltage, the F.L.A. or the R.L A., which are the same thing, and the L.R.A.

_______ d. Other important information on a data plate includes the type of refrigerant in the appliance and the amount of refrigerant required.

_______ e. Data plates on freezers are always on the back of the freezer.

_______ f. Data plates on refrigerators are placed in the lower left inside the cabinet and a crisper or sliding storage drawer may have to be removed to access the plate.

8. Complete statements about troubleshooting common problems. Write in the word(s) that best completes each of the following statements.

a. If a major problem has been identified, a refrigerated appliance can be unplugged and readily transported back to a shop for repair, but don't pack the unit off until you've completed initial troubleshooting to make sure the problem will require _______________ _______________.

b. Start by looking for a unit that has been improperly _______________ with too little circulation behind, above, or on the sides; if the unit has a static condenser, it may require repositioning to assure proper performance.

c. Check the _______________ and clean it, if necessary because it is possible that this is the only problem; truth is, you can't check the system until it has a clean _______________.

d. Check for doors that are out of _______________ or poor cabinet _______________; these conditions contribute to poor performance, but the problem can often be corrected in the customer's home.

e. Check for _______________ circulation problems caused by food placed inside the appliance in such quantities that it blocks internal circulation.

f. Check for ________________ circulation problems; if it is not a forced air system that blows circulating air out the bottom of the unit, chances are cereal boxes, pop tarts, or other boxed foods are stacked on top of the unit and restricting circulation.

g. Check for ________________ problems; if the unit is frost-free, the cycle may not be operating properly and require shop repair, but if the unit is not self-defrosting, it usually means the customer has waited too long to defrost or damaged the system while trying to defrost with a sharp object.

h. Check for defrost ________________ ________________ problems; there should be a collecting pan underneath the unit behind the toe plate; units are designed to evaporate the water, but sometimes the pan has to be emptied, and the pan should be cleaned often to control odors.

i. Check for an improperly set ______________ switch; if a unit with a ______________ switch has condensation building up on interior cabinet surfaces and around the doors, the humidity switch needs to be set on high.

j. Check for improperly set controls; some units will have two controls that permit adjustment in both the ________________ and ________________, but others such as apartment-type units will have a single control.

k. When there are two controls on a refrigerator-freezer, one setting acts as a ________________ to control the compressor while the other control is a ________________ device.

l. Check for malfunctioning electrical or refrigeration components; when you are certain the problem(s) are related to ______________ control situations or ______________ components that need replacement, then load the unit safely and get it to the shop for repairs.

9. Select true statements about considerations for transporting a refrigerated appliance. Place an "X" beside each true statement.

_______ a. Use a good appliance hand truck to manage the appliance, and always keep a refrigerated appliance upright as you load it and as you transport it.

_______ b. If you lay a refrigerator or freezer on its side, the oil could leave the compressor and cause a restriction in a refrigerant line, or worse, cause the compressor to seize when it is started up without oil around the bearings.

_______ c. If you lay a refrigerated appliance on its side, it might damage the motor windings which are spring mounted inside the dome of the compressor; if the windings hit the side of the dome, they could be damaged.

_______ d. If a refrigerator has been laid on its side, never attempt to run it until oil has been completely drained from the system and the compressor has been checked.

_______ e. Use a hydraulic or ratcheted lift to move the appliance into the service vehicle.

_______ f. Have appropriate covering and padding material to cover an appliance as you move and transport it to avoid denting or scarring a cabinet.

_______ g. Strap the refrigerator securely upright into the back of the service vehicle with tie-down straps, and avoid slamming on the brakes or making sharp turns at high speed.

10. Solve problems about installing or reinstalling a refrigerator. Write in the information that best completes each of the following statements.

a. A refrigerator you are installing has an ice maker, but you don't find a hook-up coil on the back. You should:

____

____

b. You are installing a unit that has a static condenser. Circulation requirements demand a one-inch clearance at the back and at least a three-inch clearance at the top. But why does the top clearance have to be more?

____

____

c. You note that a refrigerator you are installing will be next to a kitchen range. You should:

____

____

Written Test

11. Select true statements about disposing of small, refrigerated appliances. Place an "X" beside each true statement.

_______ a. EPA regulations make it illegal to dispose of a small, refrigerated appliance if the refrigerant has not been removed from the appliance.

_______ b. EPA regulations state that the appliance owner is responsible for removing the refrigerant or having the refrigerant removed.

_______ c. Waste sites will accept refrigerated appliances that still have refrigerant in them, but they charge extra for the service.

_______ d. Because recovered refrigerant is usually worth a little money, most ACR service companies will recover refrigerant with little or no charge to the customer; it provides the company with good public relations and saves the customer time and money.

_______ e. If a service company should choose to dispose of an appliance by completely disassembling it, the company must maintain a record of the refrigerant removed.

_______ f. Know your company policy regarding refrigerant recovery and always recover refrigerant with the right equipment, label and date the refrigerant, and transport it only in a reuseable DOT cylinder.

12. Complete statements about looking beyond the service call. Complete the following statements in such a way that they indicate you are looking beyond the service call.

a. You note to the customer that you have just serviced an old refrigerator for the second time in less than six months. It's a good time to:

____

____

b. You note that the door on a refrigerator you are reinstalling opens on the left side at an inconvenient distance from the countertop in the customer's kitchen. It's a good time to:

____

____

c. With three children in the home, you know that an old refrigerator is working overtime to keep up with the many times children open the door for ice or cold drinks. It's a good time to:

____

____

Permission to duplicate this test is granted.

Teacher Supplement 1—VICA Professional Development Program

The lead article in a recent issue of *The Air Conditioning, Heating and Refrigeration News* was a less-than-pleasant look at skilled ACR technicians who lose money for their employers. It's true! Many top-notch refrigeration technicians alienate customers. In turn, angry customers go elsewhere and even encourage their friends to go elsewhere for service, not because the service was bad, but because the service technician was irritating. Statistics presented to reinforce the *News* article were nothing less than jarring. Of the people who quit doing business with a company, those who are dissatisfied with the product account for only 14%; **a whopping 68% are alienated by the attitude of an employee!**

In other words, on-the-job attitudes that affect customer relations are often as important as on-the-job skills. Technical skills will always be a basic ACR service requirement, but modern technicians also need those valuable "people skills", the cornerstone of customer relations. And like any other skills, those people skills can be learned through professional development.

The Vocational Industrial Clubs of America prepared its *Professional Development Program* with the future technician in mind. Beyond the basic objectives of VICA as a student organization, the *PDP* presents students with activities designed to expand interpersonal skills through participation in team projects, community activities, and many other enriching participations that enhance talent and personality. The *Professional Development Program* also provides instructors with special materials to help articulate the school-to-work transition.

What industry wants in an employee is presented in a multitude of reference materials that simply put things in a list. VICA's *PDP* puts the list into a dynamic format that gives students challenging activities to accomplish and document as they prepare a permanent portfolio for reference by future employers. The program also creates a lasting, positive self-image for students.

VICA's *Professional Development Program* was assisted with grants from The J.C. Penney Company, Inc. and Sears, Roebuck and Co. The sponsorship of these two merchandising giants reflects industry concern for the people skills the *PDP* program is all about. To put your students on the "professional" track, contact VICA toll-free at 1-800-321-8422 or write:

VICA
P.O. Box 3000
Leesburg, VA 22075

Teacher Supplement 2—Talking Business on the Internet

If your program or school has access to the Internet or the World Wide Web through a system server, you can access all kinds of information related to refrigeration and air conditioning. Access to the Internet is available through the online services such as America Online, CompuServe, Prodigy, and Windows 95, or you can find direct servers to the Internet. Once you access the Internet, you will find abundant resources dedicated to refrigeration and air conditioning. As a general starting point, you can "surf" the net through a newsgroup dedicated to all kinds of general information as well as "net" people you can "chat" with about troubleshooting or other concerns. That address is:

Newsgroups: sci.engr.heat-vent-ac

For other Internet addresses you will find helpful, type:
http://www.ashrae.org

As the code name suggests, the above is the address for ASHRAE, American Society of Heating and Air-Conditioning Engineers, Inc. The ASHRAE home page on the net is dedicated to news about the latest in HVAC&R technology, news, standards, and more.

http://www.ari.org

As the code name suggestes, the above net address is for The Air-Conditioning and Refrigeration Institute. The ARI home page features ARI background, current news releases, statistical releases, historical news releases, customer brochures, and more.

http://www.acca.org

As the code name suggests, the above net address is for The Air-Conditioning Contractors of America. The ACCA home page also features up-to-the-minute news releases, special contractor information, service and application information, and more.

Net resources include changing news from the EPA, including information about refrigerants and dessicants. For news and information about refrigerants, type:
http://www.epa.gov/docs/ozone/title6/snap/ref.htm

For information about the ozone, type:
http://www.epa.gov/docs/ozone/

The major manufacturers of HVAC&R equipment are also on the net. http://www.trane.com/ will get you to the home page of the Trane Company, and other manufacturers are easy to access on the net.

TELNET is another network tool that permits you to use a password to log on to another host computer on the Internet and access specialized information. To access TELNET, you must first access an http address and then open a directory to the TELNET. The access procedure is usually as easy as following the on-screen prompts.

Call it "cyberspace" or what you will, the "net" is a quick way to access really professional assistance with problems or just to stay on top of industry news. It is a resource that will enhance classroom activities and get students involved with the "world" of HVAC&R.

Service Fundamentals
Unit 1

Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Job Sheet 1—Install a Refrigerator Rating ______

Comments:

Job Sheet 2—Adjust a Refrigerator Door Rating ______

Comments:

Job Sheet 3—Switch Refrigerator Door Orientation Rating ______

Comments:

Other:

Written Tests: __________ Pretest __________ Posttest __________

Total __________

Teacher Signature ______________________ Date __________

Student Signature ______________________ Date __________

Permission to duplicate this form is granted.

Service Fundamentals
Unit 1

Information Sheet

1. **Terms and definitions**

    a. **Appliance**—A usually self contained, electrically operated device used for household purposes; the term is used in a variety of ways by industry, federal and state agencies, and utility companies

    b. **Appliance dolly**—A wheeled dolly designed especially for transporting appliances; it has wide tie-down straps that tighten with a ratchet and usually has rollers on the back to facilitate movement up and down stairs

    c. **Compartment**—A space separated by walls and doors or drawers from ambient conditions or other compartment conditions

    d. **Data plate**—A tag affixed to an appliance to provide a permanent service reference for information about electrical characteristics and refrigerant charge

    e. **Domestic refrigeration**—Self-contained refrigerators, freezers, and other refrigerated home appliances that can be unplugged and readily transported to a service facility for repair

    f. **EER (Energy Efficiency Ratio)**—The ratio of energy output to energy input, a way of expressing how much energy is required to produce a given output; it helps manufacturers provide customers with an estimate of the annual cost of operating an appliance

    g. **Frost free**—A type of freezer designed to keep food storage areas free of frost and ice build-up to avoid the need for defrosting

    h. **Maintenance**—Procedures performed at scheduled intervals to check and service components or conditions of a refrigerated appliance in order to minimize the need for repairs and maximize system performance

    i. **Service**—Performing maintenance, troubleshooting, and/or repairs

    j. **Troubleshooting**—A systematic approach to determine the cause(s) of component malfunctions or general system problems

2. **General guidelines for domestic refrigeration service**

    a. Refrigerator and freezer problems pose special concerns for homeowners because they are an essential part of modern life styles that demand TV dinners at any time of the day and frozen strawberries for mid-winter desserts.

    b. The modern refrigerator is usually a refrigerator/freezer with the freezer above or below the fresh food compartment, or a side-by-side model with an upright freezer built into the system right beside the refrigerator.

Information Sheet

c. Many side-by-side models have in-door service for ice or cold water or both, and these components require special skills for troubleshooting and repair.

d. Problems posed by refrigerator/freezers involve more than just the need for repairs; the customer frequently will have both frozen and chilled foods that could rapidly spoil if they are not restored to a proper environment.

e. Chest and upright freezers pose special problems because they frequently contain bulk quantities of meats or seasonal fruits and vegetables that are packaged during the growing season and frozen for year-round use.

f. In all cases, a refrigerator or freezer that quits working causes special customer concern for both the inconvenience and the expense of losing food or paying for enough ice to provide temporary storage in an ice chest.

g. Whether repairs are made in the home or in the shop, refrigerators and freezers need to be repaired and returned to service as quickly as possible to alleviate concerns of anxious customers.

3. Refrigerator and freezer design objectives

a. Refrigerators and freezers are designed to safely store food for short or extended periods of time by working within design temperature ranges.

Compartment	Preferred Temperature Range	Safe Storage Limits
(1) Fresh food	33° to 38°F	Up to a week except for unfrozen meat or fish which needs to be stored as close to freezing as possible
(2) Freezer	–10° to 10°F	For several weeks, but extended freezing of a year or more requires –20°F or lower

b. By keeping food at a lower temperature, refrigerators and freezers:

1) Slow down food deterioration so food can be stored for long periods.

Information Sheet

2) Reduce the growth of bacteria so food will be safe to eat.

3) Reduce evaporation of water from food.

c. The process of removing heat also removes moisture and makes the air in an appliance very dry which in turn dries out food and affects freshness and taste.

d. Appliance compartments can be used to separate food from dry air in the appliance to help prevent food from drying out, and this can also be accomplished by proper packaging.

e. Ice crystals form as food is frozen and freezing food fast forms smaller crystals which are less damaging to the food.

f. Freezing food quickly can be done by providing a compartment with a lower temperature, or by placing food at a colder location within a compartment.

4. Compartment design objectives

a. To meet the design objectives of keeping food safe and fresh, food placed in a refrigerator or freezer requires some preparation and special storage.

b. A fresh food compartment keeps food best when the food is wrapped in foil or Saran wrap or enclosed in air-tight containers.

c. A freezer compartment keeps food best when the food is wrapped in freezer paper or sealed in moisture-proof containers.

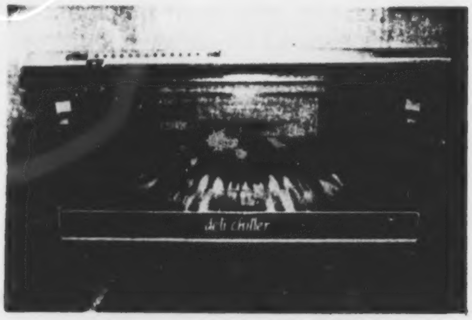
d. A butter keeper compartment isolates butter from the fresh food environment to keep it slightly warmer and easier to spread, but only if the butter compartment door is kept closed.

e. A crisper compartment at the bottom of the fresh food compartment isolates vegetables to keep them from drying out, but vegetables need to be cleaned and table-ready before they go into the crisper.

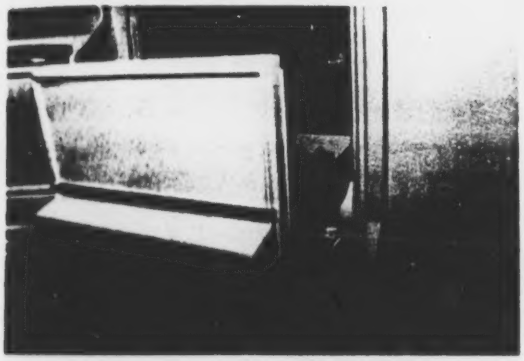
Information Sheet

f. An egg keeper uses molded indentations in a tray or door to protect eggs; indentations are designed especially to store eggs small end down to protect them from internal damage.

g. A meat keeper close to the top of the fresh food compartment where cold air first enters keeps meat or other food slightly cooler so it stays fresh longer.



h. A freezer compartment may have a bin or area to store ice made in ice trays or produced with an automatic ice maker.



i. A fast-freeze shelf or area may be located near the ice storage to freeze food quickly when it is first placed in the freezer because the area is at the beginning of the evaporator or where cold air first enters the compartment.

Information Sheet

5. **Components of a refrigerator and their functions**

   a. **Breaker strip**—Plastic trim that covers the space between the cabinet and the liner of a refrigerator

   b. **Door handle**—Provides access to interior refrigerated compartments

   c. **Door liner**—Provides a covering for in-door insulation and is formed with shelving or small storage spaces for holding food stuffs

   d. **Gasket**—A resilient, flexible material used around a refrigerator or freezer door to provide a leak-proof-seal

   e. **Inner liner**—Provides a covering for in-cabinet insulation and supports in-door shelving while providing a smooth, easy-to-clean interior

   f. **Insulation**—A barrier in exterior walls of an appliance foamed or fitted into place to resist heat entering the appliance

   g. **Mullion**—A divider that separates a freezer compartment from a refrigerator compartment

   h. **Outer liner**—Provides a covering for an entire refrigerated appliance, and is frequently enameled for easy cleaning, extended wear, and cosmetic appeal

   i. **Toe plate**—A protective barrier fitted at the bottom of the appliance to keep things from getting underneath while letting air through

6. **Considerations for in-home refrigeration service**

   a. When you service a refrigerator or freezer in a home, be prepared to face a customer that is upset with the inconvenience and wants your services completed in minimum time at minimum cost.

   b. Show up in a service truck or vehicle that is clean, and don't leave muddy tire tracks, oil spots, or anything else on a clean driveway.

   c. Look clean and sharp when you arrive, have clean shoes that don't mark a floor, and put down a drop cloth to keep the work area clean.

Information Sheet

d. Put the customer at ease by introducing yourself and explaining why you are there, but avoid extended conversations that keep you from the business at hand; you are on a service call, not a social call.

e. Politely refuse coffee or other refreshment when you are on a service call by reminding the customer that service calls are charged in time increments and being free to concentrate will speed your work and save the customer money.

f. If children or pets are running free in the area where repairs have to be made, ask the parent/owner to please keep them out of the room to assure their safety and prevent their interfering with timely completion of the service.

g. Make notes when the customer explains the problem; work orders taken over the phone may be far too general to assist with troubleshooting.

h. Ask the customer for manufacturer's literature that came with the appliance when it was new; many customers have this filed away.

i. Keep old parts so the customer will know exactly what parts were replaced, and go over the charges when you present the bill to the customer

j. If you are going to be late to a scheduled in-home service call, phone the customer to let them know how late you will be, and have a truly convincing reason for being late.

7. Data plate information and where to find it

a. Information on a data plate is critical for the proper service of refrigerated appliances because of the significant information the plate contains.

b. The data plate should indicate a brand name, a model number, and a serial number, items required for hunting parts and service literature.

GENERAL ELECTRIC

c. The data plate should also indicate the voltage, the full load amperage, usually indicated by F.L.A. or wattage, and the locked rotor amperage, abbreviated L.R.A.

Note: Some system data plates may not include all of the above items.

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Information Sheet

d. Other important information on a data plate includes the type of refrigerant in the appliance and the amount of the refrigerant charge.

Note: Some data plates may not give the exact charge.

e. Data plates are often on the back of the appliance cabinet or on the lower front of the appliance where it can be accessed by removing the toe plate.

f. Some data plates are placed in the lower left inside the cabinet and a crisper or sliding storage drawer may have to be removed to access the plate.

Note: If you don't find the data plate after looking in obvious places, keep looking; with rare exceptions, there is a data plate somewhere on the equipment.

8. Troubleshooting common problems

a. If a major problem has been identified, a refrigerated appliance can be unplugged and readily transported back to a shop for repair, but don't pack the unit off until you've completed initial troubleshooting to make sure the problem will require shop repair.

b. Start by looking for a unit that has been improperly installed with too little circulation behind, above, or on the sides; if the unit has a static condenser, it may require repositioning to assure proper performance.

c. Check the condenser and clean it, if necessary, because it is possible that this is the only problem; truth is, you can not check the system until it has a clean condenser.

d. Check for doors that are out of adjustment or poor cabinet seals; these conditions contribute to poor performance, but the problem can often be corrected in the customer's home.

e. Check for internal circulation problems caused by food placed inside the appliance in such quantities or locations that it blocks internal circulation.

f. Check for external circulation problems; if it is not a forced air system that blows circulating air out the bottom of the unit, chances are cereal boxes, boxed foods, or other items are stacked on top of the appliance and restricting circulation.

g. Check for defrost problems; if the unit is frost-free, the cycle may not be operating properly and require shop repair, but if the unit is not self-defrosting, it usually means the customer has waited too long to defrost or may have damaged the system while trying to defrost with a sharp object.

h. Check for condensate and defrost water disposal problems; there should be a collecting pan underneath the appliance behind the toe plate; appliances are designed to evaporate the water, but sometimes the pan has to be emptied, and the pan should be cleaned often to control odors.

i. Check for an improperly set humidity switch; if a unit with a humidity switch has condensation building up on interior cabinet surfaces and around the doors, the humidity switch needs to be set on high.

Information Sheet

Note: Running the humidity switch on low saves energy, but sometimes the switch has to be set on high to maintain operating conditions that will facilitate customer usage habits.

j. Check for improperly set controls; some units will have two controls that permit adjustment in both the refrigerator and freezer, but others such as apartment-type units will have a single control.

k. When there are two controls on a refrigerator-freezer, one setting acts as a thermostat to control the compressor while the other control is a damper device.

l. Check for malfunctioning electrical or refrigeration components; when you are certain the problem(s) are related to complex control situations or refrigeration components that need replacement, then load the unit safely and take it to the shop for repairs.

9. Considerations for transporting a refrigerated appliance

a. Use a good appliance dolly to manage the appliance, and always keep a refrigerated appliance upright as you load it and as you transport it.

b. If you lay a refrigerator or freezer on its side, the oil could leave the compressor and cause a restriction in a refrigerant line, or worse, cause the compressor to seize when it is started up without oil around the bearings.

c. If you lay a refrigerated appliance on its side, it might damage the motor windings which are spring mounted inside the dome of the compressor; if the windings hit the side of the dome, they could be damaged.

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Information Sheet

d. If a refrigerator has been laid on its side, place it upright for at least 24 hours before attempting to operate it.

Note: Placing the unit upright for a period does not assure that the unit will operate properly, but since the unit has not had the compressor running, oil has not circulated through the system, and the system may still operate normally.

e. Use a hydraulic or ratcheted lift to move the appliance into the service vehicle.

f. Have appropriate covering and padding material to cover an appliance as you move and transport it to avoid denting or scarring a cabinet.

g. Strap the refrigerator securely upright into the back of the service vehicle with tie-down straps (or rope), and avoid slamming on the brakes or making sharp turns at high speed.

10. Guidelines for installing or reinstalling a refrigerator

a. Read the manufacturer's instructions for installation and operation.

Note: Improper installation could avoid warranties on a new refrigerator and cause a recently repaired unit to malfunction again; if you're reinstalling an older unit that does not have manufacturer's literature available, follow safe guidelines for leveling the unit and for circulation around the unit.

b. If the unit has an icemaker/cold water service, check for a hook-up coil on the back of the unit, and if there is not one there, make one from new copper tubing, and hook up the water supply before you continue the installation.

Note: If there is no water supply line for the unit, inform your customer that your company provides that service at a slight extra charge, but make no quotes about costs until you find out where you will have to tie in to the home water service, and what materials you will need.

Information Sheet

c. Allow a minimum half-inch clearance on each side of the refrigerator and at least a one-inch clearance at the back of a model with a static condenser.

d. If the unit has a static condenser, allow at least three inches above the refrigerator for air circulation because heat from running components will rise and require more space to dissipate.

e. If the unit has rollers, lock the rollers on the bottom of the unit to keep the refrigerator positioned in place, but do not assume that locking the rollers will level the refrigerator; they will not.

f. Remember that some models have leveling adjustments on the rear as well as the front, or use a level to level the refrigerator by adjusting the leveling legs or the leveling adjustment on the rollers.

g. If the unit is next to a range or any other heat source, suggest that it be moved or shielded in some way, and if the unit is in direct sunlight, suggest a curtain or shutter to block the sunlight.

11. Disposing of small, refrigerated appliances

a. EPA regulations make it illegal to dispose of a small, refrigerated appliance if the refrigerant has not been removed from the appliance.

b. EPA regulations state that the "final person in the disposal chain" is responsible for removing the refrigerant or having the refrigerant removed.

c. Waste sites will not accept refrigerated appliances that have not had refrigerant removed, and local waste services will not pick up discarded refrigerated appliances unless they are tagged as having had the refrigerant removed.

d. Because recovered refrigerant is usually worth a little money, most ACR service companies will recover refrigerant with little or no charge to the customer; it provides the company with good public relations and saves the customer time and money.

Note: The good public relations often means the sale of a new refrigerator or freezer to the customer.

e. If a service company should choose to dispose of an appliance by completely disassembling it, the company must maintain a record of the refrigerant removed.

f. Know your company policy regarding refrigerant recovery and always recover refrigerant with the right equipment, label and date the refrigerant, and transport it only in a reuseable DOT cylinder.

12. Looking beyond the service call

a. A successful in-home service call will give the customer confidence in you and your company, and provide the perfect opportunity for you to suggest new products or an extended service contract to the customer.

Information Sheet

b. Extended service includes repairs and parts as well as maintenance, and the contract often includes all refrigerated appliances in a home, even the air conditioning; in fact, it's a good time to let the customer know that the present service call would have cost less if it had been under an extended service contract.

c. Many companies pay service technicians cash or vacation time bonuses for sales made on service calls, but be sure to perform the service well and finish it before talking about other service items with the customer.

d. If there are young children in the home, you might suggest an older refrigerator/freezer be replaced with a side-by-side model with ice and water in the door for extra convenience and energy savings.

e. If you see a refrigerator door that opens with an orientation that is inconvenient for the customer's counter arrangement, check to see if there are predrilled holes to facilitate changing the handles and hinges so doors can open in a more convenient orientation, and add the job at a minimum charge to the bill.

Note: You'd be surprised how many people put up with the inconvenience of a door that opens the wrong way; sometimes customers buy a unit with the wrong door orientation in order to take advantage of a sale price and remodeling sometimes requires a change.

f. Anytime you can offer a quick, no-charge service to the customer or offer a positive service tip, you are winning the customer's confidence, and future service calls or the need for new equipment will bring the company name to the customer's mind.

g. Being a good technician may also involve being a good salesperson or someday moving into sales, and customer confidence built up with good service is a sure road to future business.

Example: If you take notes on a service call, the customer is going to be impressed a year from now when you call to talk about a sale and still remember the color scheme in the kitchen!

Service Fundamentals
Unit 1

Job Sheet 1—Install a Refrigerator

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
Location and clearances correct	______
Refrigerator level	______
Door flush and seals secure	______

A. Tools and materials

Refrigerator and location as selected by instructor
Copper tubing, saddle valve, and fittings for water line
Appropriate hand tools
Level
Cleaning solvent and clean shop cloth

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Make sure the area where the refrigerator will be installed is clear of any obstacles that would interfere with installation.

☐ 3. Check the area to be sure the refrigerator will not be next to a range or other heat producing appliance, and that the unit will also be shielded from direct sunlight.

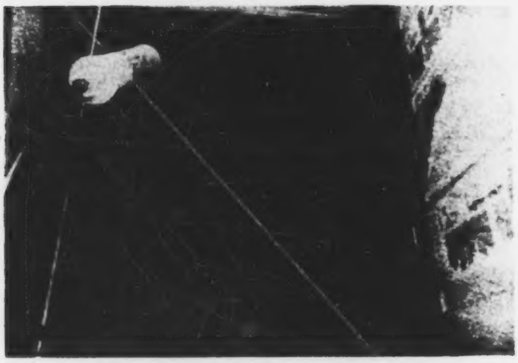
☐ 4. Locate the water source you will need to hook on to, if the unit has an ice maker or chilled water facility.

Note: If there is no access to a water supply source, check your work order and talk with the customer; you may need to call the office if the cost of installing a water line has to be paid by the customer.

☐ 5. Check for a coiled line hook-up to water service; this is made up as a coil so it will safely expand enough that you can get behind the unit to make the hookup with no problem.

Note: If there is no coiled hook-up, you may have to make one from a coil of new tubing; once again, this will be an added cost to the customer, and if the customer is there, explain the extra charge.

Job Sheet 1



☐ 6. Use wrenches to connect the water line; use one of the wrenches for backup and another to tighten the fitting; this will avoid damage to the copper water line.

☐ 7. Roll the refrigerator into place, and provide side, back, and upper clearance as follows:

  a. About half an inch on each side.

  b. At least one inch behind.

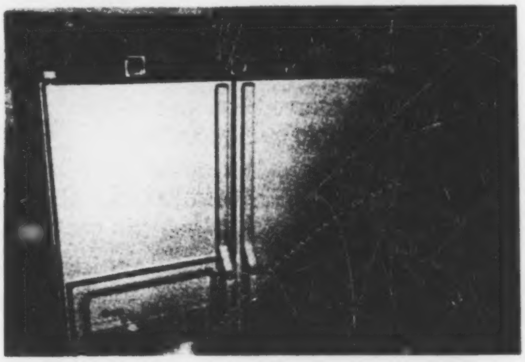
  Note: If the unit has spacers behind, simply push the unit back until the spacers touch the wall.

  c. At lest three inches above the refrigerator.

☐ 8. Remove the toe plate, if necessary.

☐ 9. If the unit has rollers, lock the rollers into place, or if the unit has a locking foot, lock it into place.

☐ 10. Level the refrigerator by setting the level across the top of the unit and adjusting the leveling legs or adjustment devices up or down to level the unit front and back and across.



Job Sheet 1

☐ 11. Remove inside packing material if it is a new refrigerator, save any owner's instructions that may be inside the refrigerator, and place racks or other storage devices into place as needed.

☐ 12. Clean the refrigerator inside and out to remove fingerprints, and make sure the refrigerator is free of inside odors.

☐ 13. Check the refrigerator doors for proper closing.

☐ 14. Replace the toe plate.

☐ 15. Present the owner's materials to the customer, and inform the customer of warranties, usage tips for good service, and a phone number where problems can be reported.

☐ 16. Have your instructor check your work.

☐ 17. Put tools and materials back into your tool box and leave the area clean.

Evaluator's Comments: ____

____

____

Service Fundamentals
Unit 1

Job Sheet 2—Adjust a Refrigerator Door

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
Door operates properly after adjustment	______
Deals operate properly after adjustment	______

A. Tools and materials

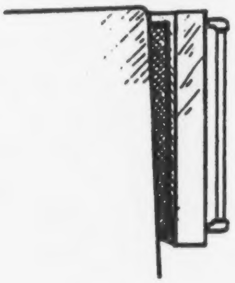
Refrigerator as selected by instructor
Phillips screwdriver
Cleaning solvent and clean shop cloth
Piece of thin paper
Safety glasses

B. Procedure

☐ 1. Put on safety glasses.

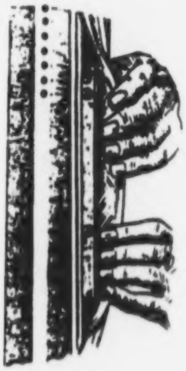
☐ 2. Check for a gap between the door gasket and the cabinet front.

Note: Some technicians insert a sheet of paper to check the door seal at various points.

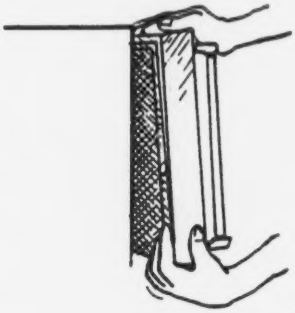


Job Sheet 2

☐ 3. Pull the gasket back so you can find the retainer screws and loosen them.



☐ 4. Check the direction of the misalignment on the door, and use both hands to twist the door in the opposite direction to correct the misalignment.



☐ 5. Close the door and check the gap and the seal on the realigned door.

☐ 6. Retighten the retainer screws until they are snug, but don't overtighten them or you may spring the door out of alignment again.

☐ 7. Check the gap and seal on the door again.

☐ 8. Clean fingerprints or other marks off the cabinet and seal.

☐ 9. Have your instructor check your adjustment.

☐ 10. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

____

____

Service Fundamentals
Unit 1

Job Sheet 3—Switch Refrigerator Door Orientation

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
Hinges and door handles properly reoriented	______
Old screwholes cosmetically sealed	______
Doors and seals checked for proper service	______

A. Tools and materials

Refrigerator w/over-under door as selected by instructor
Appropriate hand tools
Clean towel and cleaning fluid
Safety glasses

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Disconnect the refrigerator from electrical power.

☐ 3. Locate the plastic caps that cover the holes you will use to reposition the hinges and door handles.

☐ 4. Remove the caps with a thin-blade knife, but be careful not to scrape the cabinet paint, and be sure to save the caps so you can cover the holes that will be left open when you move the hardware.

Job Sheet 3

☐ 5. Clean the area around the empty screw holes so they'll be clean when you switch the hinges and handles.

☐ 6. Start with the upper compartment and remove the handle and the top hinges, and then lift the door off the center hinge which serves both doors.

☐ 7. Remove the center hinge which serves both doors, lift the lower compartment door off the bottom hinge, and remove the bottom hinge.

☐ 8. Remove the handle from each door and install it on the other side of the door.

Note: Each handle may fit only on the other door when reversed, top to bottom and bottom to top.

☐ 9. Clean the area around the empty screw holes where the hinges and handle were removed.

☐ 10. Place the cover caps you removed earlier into the screw holes left vacant by the switch, and tap them securely into place.

☐ 11. Install the lower compartment door bottom hinge onto the refrigerator cabinet.

☐ 12. Place the lower door on the bottom hinge and install the center hinge which will also serve as the lower hinge for the upper door.

☐ 13. Place the upper door onto the center hinge.

☐ 14. Install the top upper door hinge.

☐ 15. Check cabinet and freezer door for proper seal alignment and operation, and make sure the light switch works; adjust as necessary.

☐ 16. Have your instructor check your work.

☐ 17. Clean up area and return tools and materials to proper storage.

Job Sheet 3

Evaluator's Comments: ____________________

Mechanical Components and Functions
Unit 2

Objective Sheet

Unit Objective

After completing this unit, the student should be able to attach a manifold gauge set to a refrigerator or freezer using a line tap valve, and install a service valve adapter to access a refrigerator or freezer. The student should demonstrate these competencies by completing the job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to mechanical components and functions with their correct definitions.
2. Select true statements about objectives of mechanical components in a refrigerator or freezer.
3. Complete statements about compressors.
4. Complete statements about condensers.
5. Select true statements about evaporators.
6. Complete statements about metering devices.
7. Complete statements about accessories.
8. Complete a list of parameters of operating characteristics of refrigerators and freezers.
9. Select true statements about equipment and procedures for checking system pressures.
10. Solve problems about equipment and procedures for checking system temperatures.
11. Complete statements about evaluating system operations.
12. Attach a manifold gauge set to a refrigerator or freezer using a line tap valve. (Job Sheet 1)
13. Access a refrigerator or freezer with a service valve adapter. (Job Sheet 2)

Mechanical Components and Functions
Unit 2

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction or individual learning activities. Study the specific objectives to determine the order in which you will present the objectives.
2. Review Teaching Suggestions section that follows. Plan for classroom activities.
3. Plan enrichment of exceptional students as well as accommodation of special needs students.
4. Add graphic materials or overhead transparencies as needed.
5. Develop teaching plan. Adjust for different learning styles.
6. Make copies of the Unit Evaluation Form.

Delivery and Application

7. Provide students with unit of instruction.
8. Discuss unit and specific objectives.
9. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic skills when applicable.
10. Discuss and demonstrate the job sheets. Review criteria for evaluation of these activities.

Evaluation

11. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
12. Make copies of the written test. Add or modify test items as needed.
13. Give written test.
14. Compile job sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignment or job sheets.
15. Reteach and retest as required.

Teaching Suggestions

Note: Skill areas appearing in boldface type in the Teaching Suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000.* These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

Suggested Activities

1. Have different refrigerators and freezers or refrigerator-freezers available to demonstrate the types of condensers and evaporators presented in Objectives 3 and 4. Point out the value of relating the evaporator or condenser type to the total appliance design, and the importance of heat transfer in the scheme of operating conditions. Skill areas: **Basic skills, science, and listening.**

2. Have individual students report on the kind of evaporators and condensers they find on the refrigerators or freezers or refrigerator-freezers used in their homes or apartments. Tie this assignment in with Objectives 4 and 5, and require students to prepare reports from the information they gather. Have each student report his/her fact finding adventure to the class. Skill areas: **Basic skills, listening, reading, speaking; competency group, information acquisition and evaluation.**

3. Review the concept of the capillary tube as you talk about Objective 6, and also review procedures for checking system operating pressures and temperatures as presented in Objectives 9 and 10. Skill areas: **Basic skills, science, and listening.**

4. Carefully review the service work order that accompanies each of the job sheets in this unit; the work orders serve to impress students with the need to follow EPA guidelines when handling refrigerant, but the work orders are especially designed so students will develop the habit of being customer-oriented on all service calls and keeping the kind of records that impress customers with the kind of concern they look for in the people they do business with. Note also that on-site, service-call record keeping serves a vital part in the scheme of company bookkeeping and customer relations. Skills areas: **Competency group, interpersonal skills: customer service.**

Resources Used in Developing This Unit

1. Althouse, Andrew D. et al. *Modern Refrigeration and Air Conditioning.* South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.

2. *The Air Conditioning, Heating, and Refrigeration News HVAC/R Source Guide.* Troy, MI: Business News Publishing Company, 1993.

3. Wantiez, Gary W. *Air Conditioning and Refrigeration, Domestic Refrigeration.* Stillwater, OK: The Mid-America Vocational Curriculum Consortium, 1984.

4. Whitman, William C. and William M. Johnson. *Refrigeration & Air Conditioning Technology, 2nd ed.* Albany, NY: Delmar Publishers, Inc., 1991.

Suggested Activities

Suggested Supplemental Resources

The Vocational Industrial Clubs of America has published a comprehensive competency profile that outlines for students the skills required for getting and keeping a good job in the ACR industry. The profile treates traditional mechanical and electrical skills, but also lists many interpersonal skills that students need to incorporate into their training, skills that include appropriate work behavior, professional image, working relationships, and several other areas including business operations and service excellence. The Student Profile for the VICA Heating, Ventilation, Air Conditioning and Refrigeration Professional Development Program was developed by the Vocational Industrial Clubs of America with a grant from Sears Product Services. Call (703) 777-8810 for further information, or write:

Vocational Industrial Clubs of America
P.O. Box 3000
Leesburg, VA 22075

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

Mechanical Components and Functions
Unit 2

Answers to Written Test

1. a. 2
   b. 6
   c. 1
   d. 5
   e. 3
   f. 4

2. a, b, d

3. a. rotary
   b. back
   c. access to the system
   d. manifold gauge set
   e. an access valve

4. a. forced air
   b. steel, steel
   c. convection
   d. fin
   e. heat transfer
   f. tubing
   g. freezers
   h. fan
   i. underneath
   j. heat transfer

5. c, d, f, g, h

6. a. capillary tube
   b. capillary tube, soldered
   c. capillary tube, increases
   d. Automatic expansion valves

7. a. cooler
   b. filter-drier
   c. before
   d. low-load
   e. single component
   f. compressor, compressor
   g. dew point
   h. underneath
   i. condenser

8. a. Static
   b. Evaporator
   c. Evaporator
   d. Liquid
   e. Condenser

9. a, b, c, d, f, i

Answers to Written Test

10. a. 2
    b. 4

11. a. identical
    b. ambient
    c. normal
    d. stabilize
    e. operating
    f. desired, cycles off
    g. Compare
    h. troubleshooting

Mechanical Components and Functions
Unit 2

Written Test

Name ______________________________ Date ______________ Score ______________

1. Match the terms on the right with their correct definitions.

_______ a. Conditions under which a system is operating below its design capabilities

_______ b. Breaking the sealed condition of a refrigeration system and exposing the interior to the atmosphere by any means for any reason

_______ c. High- and low-side system pressures measured at selected points while a system is operating after pressures have stabilized

_______ d. System pressures measured when the system is not operating and after system pressure have not changed for several minutes

_______ e. The decrease in temperature of liquid refrigerant below its condensing point

_______ f. The increase in temperature of vapor refrigerant above its boiling point

1. Operating pressures
2. Low-load conditions
3. Subcooling
4. Superheat
5. Static pressure
6. Opening a system

2. Select true statements about purposes of mechanical components in refrigerators and freezers. Place an "X" beside each true statement.

_______ a. In refrigerators and freezers, the purposes of mechanical components are to control the temperature and humidity in compartments by removing heat and moisture.

_______ b. Objectives of mechanical components are accomplished with a self-contained, sealed compression refrigeration system.

_______ c. The mechanical components of refrigerators and freezers are different from other compression refrigeration systems because they are smaller, operate with different refrigerants, and operate at lower pressures.

_______ d. Electrical controls are used to cycle the mechanical components to maintain desired conditions.

3. Complete statements about compressors. Circle the material that best completes each of the following statements.

   a. Compressors used in domestic refrigeration are usually small hermetic reciprocal or (**scroll**) (**rotary**) compressors.

b. Refrigerator and freezer compressors are located underneath near the (**front**) (**back**) of most units, although they may be found in a variety of locations—on top, on the side, and elsewhere.

c. Compressors are manufactured with a service stub, also called a process tube or service valve, somewhere on the shell to permit (**needed modifications**) (**access to the system**).

d. A line tap valve or a service valve adapter usually has to be used to enable attaching a (**manifold gauge set**) (**vacuum pump**).

e. When an adapter is not used to enable gauge attachment, the service technician needs to install (**an access valve**) (**a shut-off valve**) onto the process tube or onto the suction line.

4. Complete statements about condensers. Write in the information required to complete each of the following statements.

a. The two basic types of condensers used on small refrigerated appliances are static condensers and ____________ ____________ condensers.

b. Since condensers are frequently exposed to the elements and careless consumer use, they are made of ____________; although ____________ is not a great conductor of heat, its durability offsets its lower heat transfer characteristics.

c. Static condensers use natural ____________ for the air circulation required to transfer heat from the refrigerant into the space surrounding the appliance.

d. A static condenser located on the back of an appliance may be a wire, ____________, or plate type.

e. Wire and fin type static condensers have wires or fins fastened to the condenser tubing, and these wires and fins provide added surface area for air to contact; this increases the rate of ____________ ____________.

f. A plate-type static condenser will also usually be on the back of an appliance and accomplishes the same heat transfer objective by attaching condenser ____________ to a sheet metal plate which adds surface area.

g. Condenser tubing may also be attached to the inner walls of the outer liner of the refrigerator or freezer cabinet; this in-wall static condenser is found on almost all ____________.

h. Forced air condensers use a ____________ to circulate air across the condenser to accomplish heat transfer.

Written Test

i. Forced air condensers are usually located ____________ the appliance, but may be on the back, the top, or some other location.

j. Forced air condensers may be only bare tubing or may use fins or plates to enlarge ____________ ____________ surface.

5. Select true statements about evaporators. Place an "X" beside each true statement.

_______ a. The two basic types of evaporators are static evaporators and plate-type evaporators.

_______ b. Forced air evaporators are made with copper tubing wrapped in thin copper fins to provide increased surface area for better heat transfer.

_______ c. Evaporators are made of aluminum because aluminum is one of the best known conductors of heat and while aluminum evaporators are easy to damage, they are usually in protected locations.

_______ d. Forced air evaporators are usually found at the bottom or back of a freezer compartment, but may be found in a variety of other locations.

_______ e. Static evaporators are made of stainless steel because they are less protected and may be exposed to consumer abuse

_______ f. Static evaporator types include shell and cold-plate types where tubing is attached to or a part of aluminum plating that may also serve as compartment walls or shelves.

_______ g. Cold-plate evaporators may surround a freezer compartment or be located at the top or back of a refrigeration compartment.

_______ h. Evaporators may also be fastened to the bottom of the shelves in an upright freezer, and these are called shelf or shelf-type evaporators.

6. Complete statements about metering devices. Write in the information that best completes each of the following statements.

a. The ____________ ____________ is the metering device found on almost all small domestic refrigerated appliances because it performs well in a narrow range of operating and ambient conditions.

b. A ____________ ____________ runs along the suction line between the external and internal compartments, and is usually ____________ to the suction line.

c. The ____________ ____________ contact with the suction line serves as a heat exchanger which ____________ the subcooling and the superheat.

d. ____________ ____________ ____________ or electronic metering devices are found on some refrigerator or freezer models, but are relatively uncommon.

Written Test

7. Complete statements about accessories. Write in the word(s) that best completes each of the following statements.

   a. Other mechanical components found on domestic refrigerated appliances include a liquid line filter-drier, an accumulator or receiver, and an oil ____________.

   b. A liquid line filter or ____________-____________ is included on every refrigerated appliance and must be replaced anytime the system has been opened in order to catch contaminants which may have entered the system.

   c. The liquid line filter or filter-drier will always be located immediately ____________ the metering device.

   d. An accumulator or a liquid receiver may be used to store excess refrigerant under ____________-____________ conditions.

   e. Sometimes the liquid receiver and the liquid line filter-drier will be a ____________ ____________.

   f. Many refrigerated appliances use a small, separate coil as an oil cooler to cool the oil in the ____________; the cooler is connected directly to additional stubs sticking out of the ____________.

   g. Since most evaporators operate at temperatures below the ____________ ____________ of the moisture in the air in the appliance, condensation constantly removes moisture from the air and the water is directed to a pan beneath the appliance.

   h. The oil cooler or a small separate section of the condenser coil is occasionally placed ____________ the condensate pan to help evaporate condensate water.

   i. Some units place the condensate pan in the air stream exiting the ____________ so passing air will help evaporate the condensate water which may also include some water from defrost runoff.

Written Test

8. Complete a list of parameters of operating characteristics of refrigerators and freezers. Write in the word that best completes each section in the following chart.

Parameters	Conditions: R-12 at 70°F	Conditions: R-12 at 90°F
a. ________ pressure	70 psig	100 psig
b. ________ pressure at start and end of cycle	Start: 12 psig End: 4 psig	Start: 12 psig End: 4 psig
c. ________ temperature at start and end of cycle	Start: 15°F End: –8°F	Start: 15°F End: –8°F
d. ________ line pressure at start and end of cycle	Start: 70 psig End: 120 psig	Start: 100 psig End: 160 psig
e. ________ entering and exiting air temperature at end of cycle	Entering: 70°F Exiting: 102°F	Entering: 90°F Exiting: 120°F

9. Select true statements about equipment and procedures for checking system pressures. Place an "X" beside each true statement.

________ a. In order to use a manifold gauge set to check static and operating pressures, you have to access the system.

________ b. If some kind of valve is not present to accept a refrigeration hose, you must install a valve or use an adapter.

________ c. The preferred place to access the system is on the low pressure side, either on the compressor or the suction line.

________ d. In some situations, both low and high-pressure access is required, and in other situations, only high-pressure access is available.

________ e. The preferred place to access the high pressure side of the system is on or near the condenser.

________ f. You may use a hermetic service valve adapter to hook on to a high- or low-side charging valve which is located on the side of the compressor.

________ g. Once you install the required valve or adapter, hook the manifold gauge set to the system just after you start the system.

________ h. Under some conditions, the low side operating pressure may be in a vacuum; installing gauges while the system is running under these conditions would help make system pressure readings more accurate.

________ i. Only technicians certified under EPA regulations should install gauges.

Written Test

10. Solve problems about equipment and procedures for checking system temperatures. Circle the number of the item that best solves each of the following problems.

    a. Another technician is headed for a service call that will involve checking temperatures. You notice that the technician placing a pocket thermometer in a tool kit. To be fully prepared for the service call, the technician should:

        1) Take at least two pocket thermometers so temperatures in different compartments can be measured at the same time.

        2) Take one or two thermometers with remote sensors so multiple temperature readings can be made and readings can also be made on difficult-to-access tubing.

    b. On a refrigerator service call, you have checked ambient air temperature and the temperature of all compartments, but you're having trouble figuring the exact nature of the problem. You may need to:

        1) Check exiting evaporator air temperature and exiting condenser air temperature.

        2) Check suction line temperature about 6 inches out from the compressor, and check liquid line temperature near the liquid line filter drier.

        3) Double check all your basic readings.

        4) Both (1) and (2) above.

11. Complete statements about evaluating system operations. Write in the material that best completes each of the following statements.

    a. Once the gauge set is installed, record static pressure readings; high and low side readings should be very close to ____________.

    b. Record the ____________ temperature, and the compartment temperatures.

    c. Set controls for ____________ operating conditions; these settings are usually indicated on or near interior controls or in the owner's manual.

    d. Start the system and allow pressures to ____________, meaning, allow the system to run until operating pressures remain relatively stable.

    e. After ____________ pressures stabilize, record operating pressures and compartment temperatures.

    f. When the compartment temperatures approach ____________ settings, and just before the system ____________ ____________, record operating pressures and compartment temperatures again.

Written Test

g. ____________ the recorded pressures and temperatures to the operating temperature/pressure guide provided by the manufacturer or a guide which shows average operating conditions for the type of equipment being serviced.

h. If at any point the operating conditions do not match the guide use a standard ____________ procedure to locate the problem.

Permission to duplicate this test is granted.

Mechanical Components and Functions
Unit 2

Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Job Sheet 1—Attach a Manifold Gauge Set to a Refrigerator or Freezer Using a Line Tape Valve Rating ______

Comments:

Job Sheet 2—Access a Refrigerator or Freezer With a Service Valve Adapter Rating ______

Comments:

Other:

Written Tests: __________ Pretest __________ Posttest __________

Total __________

Teacher Signature ______________________ Date __________

Student Signature ______________________ Date __________

Permission to duplicate this form is granted.

Mechanical Components and Functions
Unit 2

Information Sheet

1. **Terms and definitions**

    a. **Low-load conditions**—Conditions under which a system is operating below its design capabilities

    b. **Opening a system**—Breaking the sealed condition of a refrigeration system and exposing the interior to the atmosphere by any means for any reason

    c. **Operating pressures**—High- and low-side system pressures measured at selected points while a system is operating after pressures have stabilized

    d. **Static pressures**—System pressures measured when the system is not operating and after system pressures have not changed for several minutes

    e. **Subcooling**—The decrease in temperature of liquid refrigerant below its condensing point

    f. **Superheat**—The increase in temperature of vapor refrigerant above its boiling point

2. **Purposes of mechanical components in refrigerators and freezers**

    a. In refrigerators and freezers, the purpose of mechanical components are to control the temperature and humidity in compartments by removing heat and moisture.

    b. Objectives of mechanical components are accomplished with a self-contained, sealed compression refrigeration system.

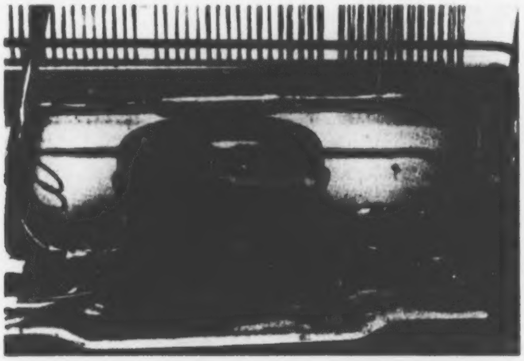
    c. The mechanical components of refrigerators and freezers are the same basic components found in any compression refrigeration system.

    d. Electrical controls are used to cycle the mechanical components to maintain desired conditions.

Information Sheet

3. Compressors

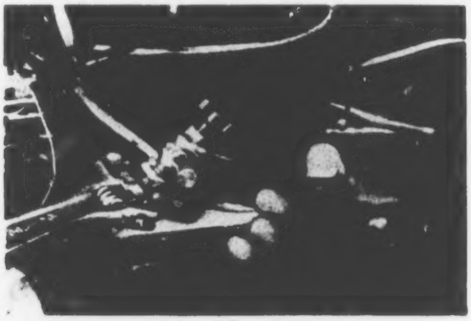
a. Compressors used in domestic refrigeration are usually small hermetic reciprocal or rotary compressors.



b. Refrigerator and freezer compressors are located underneath near the back of most units, although they may be found in a variety of locations—on top, on the side, and elsewhere.

c. Compressors are manufactured with a service stub, also called a process tube or service valve, somewhere on the shell to permit access to the system.

d. A line tap valve or a service valve adapter usually has to be used to enable attaching a manifold gauge set.



e. When an adapter is not used to enable gauge attachment, the service technician needs to install an access valve on the process tube or on the suction line.

4. Condensers

a. The two basic types of condensers used on small refrigerated appliances are static condensers and forced air condensers.

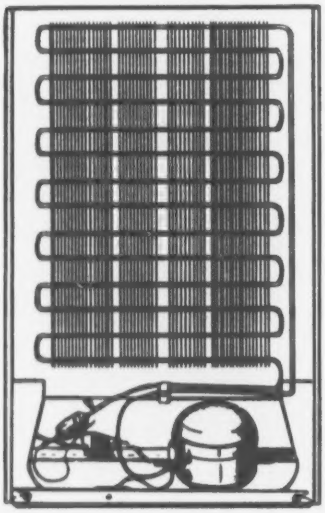
b. Since condensers are frequently exposed to the elements and careless consumer use, they are made of steel; although steel is not a great conductor of heat, its durability offsets its lower heat transfer characteristics.

Information Sheet

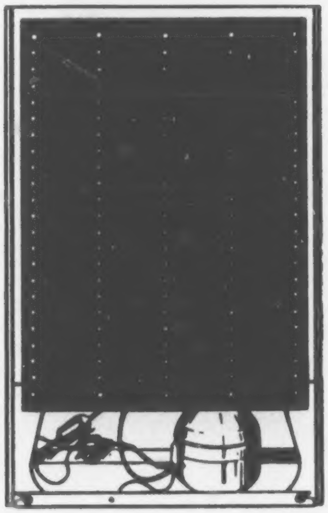
c. Static condensers use natural convection for the air circulation required to transfer heat from the refrigerant into the space surrounding the appliance.

d. A static condenser located on the back of an appliance may be a wire, fin, or plate type.

e. Wire and fin type static condensers have wires or fins fastened to the condenser tubing, and these wires and fins provide added surface area for air to contact; this increases the rate of heat transfer.

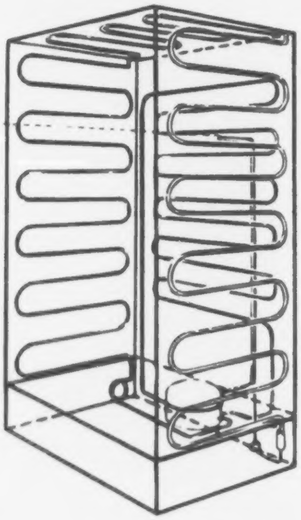


f. A plate-type static condenser will also usually be on the back of an appliance and accomplishes the same heat transfer objective by attaching condenser tubing to a sheet metal plate which adds surface area.



Information Sheet

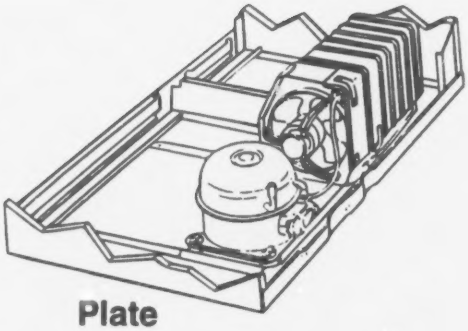
g. Condenser tubing may also be attached to the inner walls of the outer liner of the refrigerator or freezer cabinet; this in-wall static condenser is found on almost all freezers.



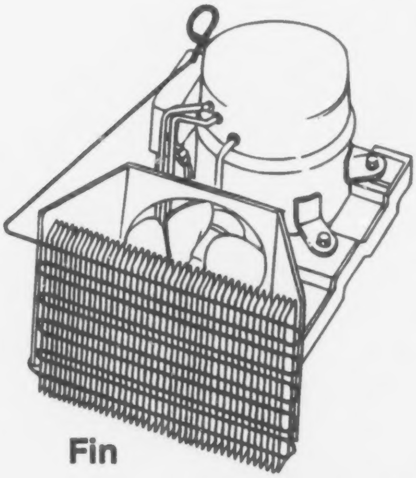
h. Forced air condensers use a fan to circulate air across the condenser to accomplish heat transfer.

i. Forced air condensers are usually located underneath the appliance, but may be on the back, the top, or some other location.

j. Forced air condensers may be only bare tubing or may use fins or plates to enlarge heat transfer surface.

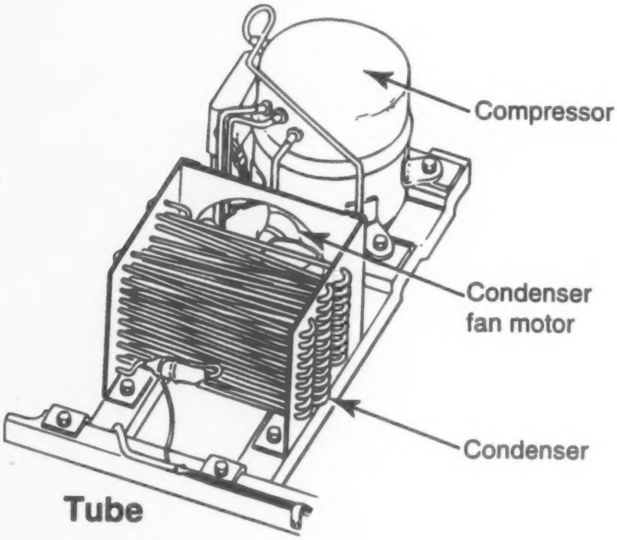


Plate



Fin

Information Sheet


Compressor
Condenser fan motor
Condenser
Tube

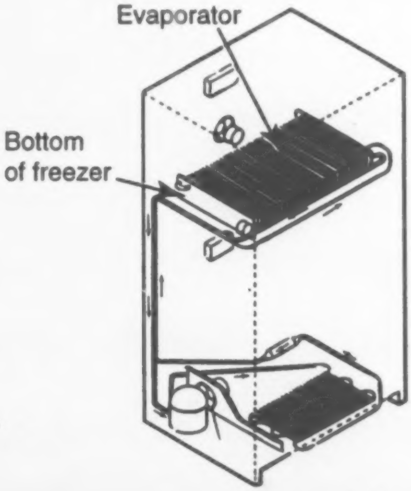
5. Evaporators

a. The two basic types of evaporators are static evaporators and forced air evaporators.

b. Forced air evaporators are made with aluminum tubing wrapped in aluminum fins to provide increased surface area for better heat transfer.

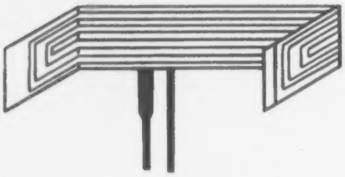
c. Evaporators are made of aluminum because aluminum is one of the best known conductors of heat and while aluminum evaporators are easy to damage, they are usually in protected locations.

d. Forced air evaporators are usually found at the bottom or back of a freezer compartment, but may be found in a variety of other locations.

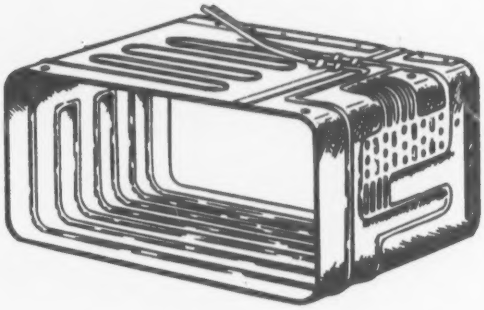

Evaporator
Bottom of freezer

Information Sheet

e. Static evaporators include shell and cold-plate types where tubing is attached to or part of aluminum plating that may also serve as compartment walls or shelves



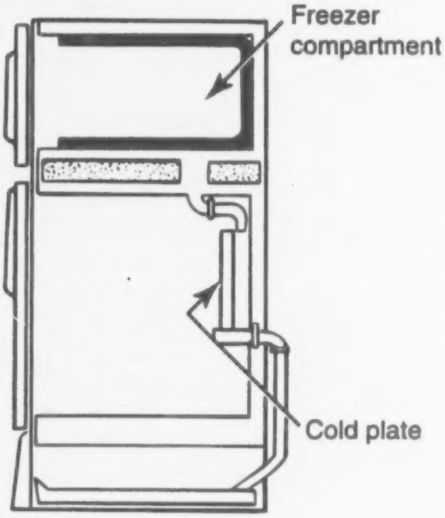
Cold Plate



Shell

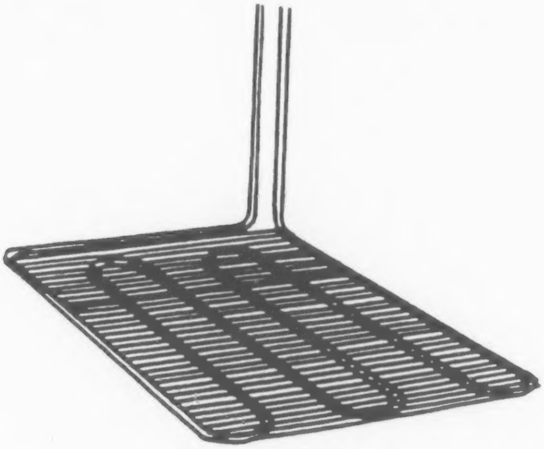
f. Static evaporators are also made of aluminum, but usually thicker, more durable aluminum than forced air varieties because they are less protected and may be exposed to user abuse.

g. Cold-plate evaporators may surround a freezer compartment or be located at the top or back of a refrigeration compartment.



Information Sheet

h. Evaporators may also be fastened to the bottom of the shelves in an upright freezer, and these are called shelf or shelf-type evaporators.



6. **Metering devices**

   a. The capillary tube is the metering device found on almost all small domestic refrigerated appliances because it performs well in a narrow range of operating and ambient conditions.

   b. A capillary tube runs along the suction line between the external and internal compartments, and is usually soldered to the suction line.

   c. The capillary tube contact with the suction line serves as a heat exchanger which increases the subcooling and the superheat.

   d. Automatic expansion valves or electronic metering devices are found on some refrigerator or freezer models, but are relatively uncommon.

7. **Accessories**

   a. Other mechanical components found on domestic refrigerated appliances include a liquid line filter-drier, an accumulator or receiver, and an oil cooler.

   b. A liquid line filter or filter-drier is included on every refrigerated appliance and must be replaced anytime the system has been opened in order to catch contaminants which may have entered the system.

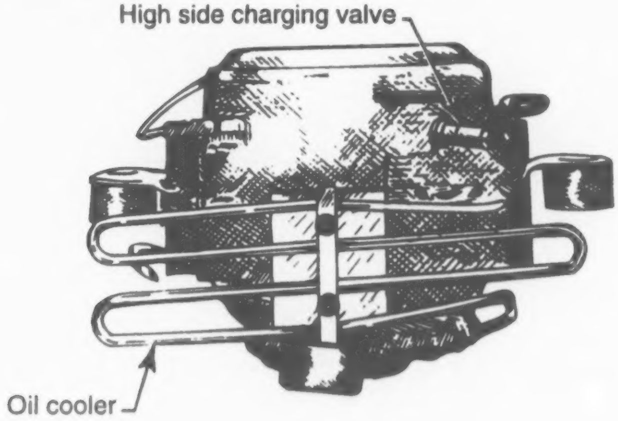
   c. The liquid line filter or filter-drier will always be located immediately before the metering device.

   d. An accumulator or a liquid receiver may be used to store excess refrigerant under low-load conditions.

   e. Sometimes the liquid receiver and the liquid line filter-drier will be a single component.

Information Sheet

f. Many refrigerated appliances use a small, separate coil as an oil cooler to cool the oil in the compressor; the oil cooler is connected directly to additional stubs sticking out of the compressor.



g. Since most evaporators operate at temperatures below the dew point of the moisture in the air in the appliance, condensation constantly removes moisture from the air and the water is directed to a pan beneath the appliance.

h. The oil cooler or a small, separate section of the condenser coil is occasionally placed underneath the condensate pan to help evaporate condensate water.

i. Some units place the condensate pan in the air stream exiting the condenser so passing air will help evaporate the condensate water which may also include some water from defrost runoff.

8. Parameters of operating characteristics of refrigerators and freezers

a. Only one set of operating characteristics need to be considered because refrigerator-freezers operate at approximately the same pressures as a freezer.

b. In all service situations, if the manufacturer's specifications are available, use them!

c. The primary considerations for evaluating operating pressures are ambient temperature, compartment temperature, and type of condenser.

d. The following chart shows average temperature/pressure conditions in a domestic refrigerator-freezer using R-12.

Information Sheet

Parameters	Conditions: R-12 at 70°F	Conditions: R-12 at 90°F
a. Static pressure	70 psig	100 psig
b. Evaporator pressure at start and end of cycle	Start: 12 psig End: 4 psig	Start: 12 psig End: 4 psig
c. Evaporator temperature at start and end of cycle	Start: 15°F End: –8°F	Start: 15°F End: –8°F
d. Liquid line pressure at start and end of cycle	Start: 70 psig End: 120 psig	Start: 100 psig End: 160 psig
e. Condenser entering and exiting air temperature at end of cycle	Entering: 70°F Exiting: 102°F	Entering: 90°F Exiting: 120°F

9. Equipment and procedure for checking system pressures

a. In order to use a manifold gauge set to check static and operating pressures, you have to access the system.

b. If some kind of valve is not present to accept a refrigeration hose, you must install a valve or use an adapter.

c. The preferred place to access the system is on the low pressure side, either on the compressor or the suction line.

d. In some situations, both low and high-pressure access is required, and in other situations, only high-pressure access is available.

e. The preferred place to access the high pressure side of the system is on or near the liquid line filter-drier.

f. You may use a hermetic service valve adapter to hook on to a high- or low-side charging valve which is located on the side of the compressor.

Note: Some appliance brands require a special adapter to hook onto their units.

g. Once you install the required valve or adapter, hook the manifold gauge set to the system before you start the system.

h. Under some conditions, the low side operating pressure may be in a vacuum; installing gauges while the system is running under these conditions would inject air into the system.

i. Only technicians certified under EPA regulations should install gauges.

10. Equipment and procedures for checking system temperatures

a. In order to read the variety of temperatures necessary to evaluate system operation, you need one or more quality thermometers.

Information Sheet

b. You will get best temperature-measuring results by using a thermometer with one or more remote sensors, and this can be an electric, an electronic, or a liquid-filled bulb model.

c. Using a thermometer or a recording thermometer with remote sensors allows you to take temperature readings inside closed compartments or on difficult-to-access tubing.

d. Temperatures critical to evaluate system operation include:

   1) ambient temperature, the temperature of the air surrounding the appliance.

   2) temperatures of the major compartments of the appliance.

e. Temperatures which may be needed to evaluate system operation include:

   1) evaporator temperature.

   2) exiting evaporator air temperature.

   3) exiting condenser air temperature.

   4) suction line temperature about 6 inches out from the compressor.

   5) liquid line temperature near the liquid line filter drier.

11. Evaluating system operations

a. Once the gauge set is installed, record static pressure readings; high and low side readings should be very close to identical.

Note: If the type of refrigerant is unknown, the static pressure readings will help determine what type of refrigerant is in the system.

Caution: Before taking static pressure readings, make sure the system has not been operating for at least 20 minutes so that there is little possibility that the low-side pressure will be in a vacuum.

b. Record the ambient temperature, and the compartment temperatures.

c. Set controls for normal operating conditions; these settings are usually indicated on or near interior controls or in the owner's manual.

d. Start the system and allow pressures to stabilize, meaning, allow the system to run until operating pressures remain relatively stable.

Note: Pressures will change rapidly when the unit first starts, slow as operations become stable, and continue slowly changing until compartments reach desired temperatures and operating controls stop the cycle.

e. After operating pressures stabilize, record operating pressures and compartment temperatures.

Information Sheet

f. When the compartment temperatures approach desired settings, and just before the system cycles off, record operating pressures and compartment temperatures again.

g. Compare the recorded pressures and temperatures to the operating temperature/pressure guide provided by the manufacturer or a guide which shows average operating conditions for the type of equipment being serviced.

h. If at any point the operating conditions do not match the guide, use a standard troubleshooting procedure to locate the problem.

Note: Use the manufacturer's troubleshooting guide, if available; standard troubleshooting procedures will be covered in a later unit of this text.

Mechanical Components and Functions
Unit 2

Job Sheet 1—Attach a Manifold Gauge Set to a Refrigerator or Freezer Using a Line Tap Valve

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
System properly accessed	______
Pressure and temperature readings correctly measured	______
Service Work Order completed for office use	______
Operating Conditions Chart completed for unit evaluation	______

A. Tools and materials

Refrigerator or freezer as selected by instructor
Appropriate service literature
Manifold gauge set
Line tap valve, clamp-on or sweat type
Soldering/brazing torch
Flux and soldering/brazing rod as required
Copper cleaning tools and supplies as required
Open end wrenches
Hex key wrenches
Thermometer(s) with remote sensor(s)
Safety glasses and colored safety glasses
Clean shop cloth(s)
Service Work Order w/Operating Conditions Chart

B. Procedure

Special application note: Accessing a system and applying gauges as called for in this job sheet require technicians to be certified under EPA regulations; only "de minimus" refrigerant emissions are allowed in service procedures.

☐ 1. Consult customer/instructor for special information that may affect servicing.

☐ 2. Obtain manufacturer's operating instructions or troubleshooting information, if available.

☐ 3. Put on safety glasses.

Job Sheet 1

☐ 4. Locate compressor process tube and determine if it is long enough to have a valve installed on it.

☐ 5. Install the line tap valve onto the process tube if the tube is long enough, and if the tube is not long enough, install the line tap valve onto the suction line (see valve installation instructions).

Caution: Be sure to leak test the valve after installation and before tapping into the system.

☐ 6. Attach the low side hose of the manifold gauge set to the line tap valve.

☐ 7. Have your instructor inspect your work.

☐ 8. Open the line tap valve, if necessary, and purge the hose at the manifold.

☐ 9. Observe the static pressure reading on the low side gauge and record it here:

____

☐ 10. Measure the ambient temperature and record it here: ______________

☐ 11. Measure the major compartment temperature(s) and record here:

____

☐ 12. Locate the operating controls and determine their normal settings by reading instructions inside or on the appliance or in the manufacturer's literature.

☐ 13. Start the system and allow pressures to stabilize.

☐ 14. Observe low-side pressure and record it here: ______________

☐ 15. Measure major compartment temperature(s) and record here:

____

☐ 16. When the major compartment temperatures approach desired settings, which should be just before the system cycles off, observe low-side pressure and record here: ______________, and measure major compartment temperature(s) and record here: ______________________

☐ 17. Record your temperature/pressure readings in the operating conditions chart on the service work order.

Job Sheet 1

☐ 18. Compare the recorded pressures and temperatures to the operating temperature/pressure guide provided by the manufacturer or a guide which shows average operating conditions for this type of equipment.

☐ 19. Write on your service work order your evaluation of the unit's general condition and performance.

☐ 20. Report your findings to and discuss them with the customer/instructor.

☐ 21. Clean up area and return tools and equipment to proper storage.

☐ 22. Complete required paper work and turn it in to your dispatcher/instructor.

Evaluator's Comments: ____________________

____

____

Job Sheet 1

Service Work Order

Customer's Name ______________________________

Customer's Address ______________________________

Brief description of problem ______________________________

____

____

Time and date service or repair started ______________________________

Time and date service or repair ended ______________________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ______________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ______________

What amount of refrigerant was added? ______________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type? ________ Amount? ______

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ______________________ Date ______________

Job Sheet 1

Service Work Order

Evaluation of unit condition and general performance:

____

____

____

____

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
e. Liquid line pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
f. Evaporator temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
g. Other compartment temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
h. Condenser air temperatures at end of cycle	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
i. Additional information			
j. Additional information			

k. Technician signature ______________________ Date ____________

Mechanical Components and Functions
Unit 2

Job Sheet 2—Access a Refrigerator or Freezer With a Service Valve Adapter

Name ______________________________ Attempt Number ____________

Date ______________________________ Overall Rating ____________

Evaluation Criteria	**Rating**
Service valve adapter properly installed	______
Pressure and temperature readings correctly measured	______
Service Work Order completed for office use	______
Operating Conditions Chart completed for unit evaluation	______

A. Tools and materials

Refrigerator or freezer as selected by instructor
Appropriate service literature
Manifold gauge set
Variety of service valve adapters
Open end wrenches
Hex key wrenches
Thermometer(s) with remote sensor(s)
Leak detector
Safety glasses
Clean shop cloth(s)
Service Work Order w/Operating Conditions Chart

B. Procedure

> **Special application note:** Accessing a system and applying gauges as called for in this job sheet require technicians to be certified under EPA regulations; only "de minimus" refrigerant emissions are allowed in service procedures.

☐ 1. Consult customer/instructor for special information that may affect servicing.

☐ 2. Obtain manufacturer's operating instructions or troubleshooting information, if available.

☐ 3. Put on safety glasses.

☐ 4. Locate the service valve fitting on the compressor or other location.

☐ 5. Clean the exterior of the valve fitting and remove the dust cover if it has one.

Job Sheet 2

☐ 6. Identify the type of service valve fitting.

☐ 7. Select a service valve adapter that has a valve stem drive compatible with the service valve fitting identified in Step 6.

Note: The service valve fitting may match the adapter stem with a slot, a hexagonal hole, a splined inset, a bolt head, or some other mating configuration.

☐ 8. Push the service valve stem forward through the body of the adapter.

☐ 9. Place a gasket into the open end of the adapter so that it fits around the stem of the adapter.

Note: The gasket may be a synthetic material or copper.

☐ 10. Engage the adapter valve stem into the service valve fitting.

☐ 11. Thread the valve adapter onto or into the fitting.

☐ 12. Tighten the packing nut or fitting around the valve stem.

☐ 13. Attach the low side hose of the manifold gauge set to the service opening on the service valve adapter.

☐ 14. Turn the valve stem counterclockwise a few turns until pressure is indicated on the low-side gauge, and then purge the hose at the manifold.

☐ 15. Have your instructor inspect your installation.

☐ 16. Check for leaks where the adapter attaches to the fitting, at the stem packing nut, and where the hose attaches to the adapter.

☐ 17. Eliminate leaks by tightening fittings, reversing steps 8 through 14 and then repeating steps 8 through 14.

☐ 18. Observe the static pressure reading on the low side gauge and record it here:

____

☐ 19. Measure the ambient temperature and record it here: ____________________

☐ 20. Measure the major compartment temperatures and record here:

____

____

☐ 21. Locate the operating controls and determine their normal settings by reading instructions inside the appliance, on the appliance, or in manufacturer's literature.

Job Sheet 2

☐ 22. Start the system and allow pressures to stabilize.

☐ 23. Observe the low-side pressure and record it here: ____________________

☐ 24. Measure major compartment temperatures and record here:

____

____

☐ 25. When the major compartment temperatures approach desired settings, which should be just before the system cycles off, observe the low-side pressure and record it here: ________________, and measure the major compartment temperatures once again and record them here:

____

____

☐ 26. Record your temperature/pressure readings in the operating conditions chart on the service work order that accompanies this job sheet..

☐ 27. Compare the recorded pressures and temperatures to the operating temperature/pressure guide provided by the manufacturer or a guide which shows average operating conditions for this type of equipment..

☐ 28. Write on your service order your evaluation of the unit's general condition and performance.

☐ 29. Close the service valve by turning the handle clockwise.

☐ 30. Report your findings to and discuss them with your customer/instructor.

☐ 31. Disconnect the manifold gauge set and remove the service valve adapter by reversing the installation procedure.

☐ 32. Clean up area and return tools and materials to proper storage.

☐ 33. Complete required paper work and turn it into your dispatcher/instructor.

Evaluator's Comments: ____

____

____

Job Sheet 2

Service Work Order

Customer's Name ______________________________

Customer's Address ______________________________

Brief description of problem ______________________________

____

____

Time and date service or repair started ______________________________

Time and date service or repair ended ______________________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ______________________________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ______________________________

What amount of refrigerant was added? ______________________________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type?__________ Amount? ________

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ______________________________ Date ______________

Job Sheet 2

Service Work Order

Evaluation of unit condition and general performance: ______________________________

____

____

____

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
e. Liquid line pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
f. Evaporator temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
g. Other compartment temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
h. Condenser air temperatures at end of cycle	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
i. Additional information			
j. Additional information			

k. Technician signature ______________________ Date ______________

Electrical Components and Control Devices
Unit 3

Objective Sheet

Unit Objective

After completing this unit, the student should be able to identify heater circuits on a schematic, identify control circuits on a schematic, replace a temperature control, and replace a defrost heater. The student should demonstrate these competencies by completing the assignment and job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to electrical components and control devices with their correct definitions.
2. Complete statements about the purposes of electrical components and control devices.
3. Select true statements about temperature controls.
4. Solve problems about compressor start components.
5. Select true statements about air flow.
6. Complete statements about controls and conditions for major compartments.
7. Select true statements about controls and conditions for compartments within compartments.
8. Solve problems about controlling frost and ice accumulation.
9. Select true statements about electric defrost.
10. Select true statements about hot gas defrost.
11. Identify heater circuits on a schematic. (Assignment Sheet 1)
12. Identify controls on a schematic. (Assignment Sheet 2)
13. Replace a temperature control. (Job Sheet 1)
14. Replace a defrost heater. (Job Sheet 2)

Electrical Components and Control Devices
Unit 3

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction or individual learning activities. Study the specific objectives to determine the order in which you will present the objectives.
2. Review Teaching Suggestions section that follows. Plan for classroom activities.
3. Plan enrichment of exceptional students as well as accommodation of special needs students.
4. Add graphic materials or overhead transparencies as needed.
5. Develop teaching plan. Adjust for different learning styles.
6. Make copies of the Unit Evaluation Form.

Delivery and Application

7. Provide students with unit of instruction.
8. Discuss unit and specific objectives.
9. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic skills when applicable.
10. Discuss the assignment and job sheets, and demonstrate the job sheets. Review criteria for evaluation of these activities.

Evaluation

11. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
12. Make copies of the written test. Add or modify test items as needed.
13. Give written test.
14. Compile assignment sheet ratings, job sheet ratings, and written test scores on the Unit Evaluation Form. Include any additional assignment or job sheets.
15. Reteach and retest as required.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the Teaching Suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

1. Have a used appliance available to demonstrate items in the information sheet. Be sure the unit has a split-phase motor for use in demonstrating the compressor start components listed in Objective 4. Explain start component operations and some of the basics of start component troubleshooting. Skill areas: **Basic skills, listening.**

2. Have individual students report on the kind of refrigerator-freezer used in their home or apartment. Have the report include brand names, cubic foot capacities, special features, and compressor data. Have each student report his/her fact finding adventure to the class. Skill areas: **Basic skills, listening, reading, speaking; competency group, information acquisition and evaluation.**

3. Have examples of manufacturers' schematics as you discuss Objectives 8, 9, and 10. Demonstrate the relationship of circuits that control the heaters used in the appliance. Have students discuss those relationships and relate them to the appliance they used for previous information gathering. Skill areas: **Basic skills, science.**

Resources Used in Developing This Unit

1. Althouse, Andrew D. et al. *Modern Refrigeration and Air Conditioning*. South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.

2. *The Air Conditioning, Heating, and Refrigeration News HVAC/R Source Guide*. Troy, MI: Business News Publishing Company, 1993.

3. Wantiez, Gary W. *Air Conditioning and Refrigeration, Domestic Refrigeration*. Stillwater, OK: The Mid-America Vocational Curriculum Consortium, 1984.

4. Whitman, William C. and William M. Johnson. *Refrigeration & Air Conditioning Technology, 2nd ed.* Albany, NY: Delmar Publishers, Inc., 1991.

Suggested Supplemental Resources

Air Conditioning, heating, and Refrigeration Dictionary is a 1995 update by Tom Zyrick. It is a pocket sized reference that includes all important definitions used in e industry. The publisher indicates that it is "chock full" of reference charts and tables to help with everything from sizing pipe to determining capillary tube lengths. For information, contact the Business News Publishing Company in Troy, Michigan at 1-800-837-1037.

Suggested Activities

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

Electrical Components and Control Devices
Unit 3

Answers to Assignment Sheets

Assignment Sheet 1

a. Perimeter heater
b. Mullion heater
c. Defrost heater
d. Drain trough heater

Note: Order may vary.

Assignment Sheet 2

a. Energy saver switch
b. Light switch
c. Defrost thermostat
d. Temperature control
e. Fan switch
f. Defrost timer
g. Relay (overload protector also acceptable)

Note: Order may vary.

Electrical Components and Control Devices
Unit 3

Answers to Written Test

1.
    - a. 3
    - b. 4
    - c. 1
    - d. 5
    - e. 2

2. a, c, d, e

3.
    - a. thermostats
    - b. fans
    - c. compartment
    - d. primary
    - e. evaporator
    - f. compensator
    - g. wide range

4.
    - a. split-phase
    - b. start
    - c. (1) Coil-type
      (2) Hot-wire-type
      (3) Solid-state
    - d. capacitor
    - e. excessive

5.
    - a. 2)
    - b. 1)
    - c. 2)

6. a, d, e, f

7.
    - a. door
    - b. fast-freeze
    - c. evaporator
    - d. fast-freeze
    - e. heaters
    - f. lower
    - g. Humidity
    - h. perimeter
    - i. low

8.
    - a. evaporator
    - b. heat
    - c. fill-tube-heaters
    - d. air flow
    - e. trough
    - f. discharge
    - g. defrost cycle
    - h. convenience

Answers to Written Test

9.
    a. underneath
    b. continuous
    c. run
    d. low
    e. first
    f. heater
    g. termination
    h. termination
    i. compartments
    j. cooling
    k. drain trough

10. a, b, c, d, e, g

Electrical Components and Control Devices
Unit 3

Written Test

Name ______________________ Date ____________ Score ____________

1. Match terms related to electrical components and control devices with their definitions. Write the corresponding numbers on the blanks provided.

_______ a. Removing frost and ice accumulation from an evaporator and other areas where frost and ice accumulate

_______ b. That part of an appliance cabinet around a compartment door opening

_______ c. The difference between the cut-in and cut-out settings of a control

_______ d. Moisture accumulation on cabinet walls or other locations which takes place during high humidity conditions in ambient air

_______ e. The stopping of a cycle or a function

1. Range
2. Termination
3. Defrost
4. Perimeter
5. Sweating

2. Select true statements about the objectives of electrical components and control devices. Place an "X" beside each true statement.

_______ a. In refrigerators and freezers, desired temperature and humidity are maintained using electrical components to control air flow, and/or add heat at selected locations in various compartments.

_______ b. Electrical components in a refrigerated appliance do not accomplish work, but they control components that accomplish work.

_______ c. Electrical components may also be used to control frost accumulation in refrigerated appliances.

_______ d. How the electrical components relate to each other is shown on one or more electrical diagrams which accompany each appliance.

_______ e. Other control devices usually are some type of damper to control air flow and are operated manually or by a mechanical temperature control.

3. Complete statements about temperature controls. Write in the word that best completes each of the following statements.

a. Temperature controls, also called ____________ or cold controls, start and stop the compressor motor or one or more heaters in response to changing temperatures in the compartments.

Written Test

b. Temperature controls may also be used to stop and start ____________ or open and close dampers.

c. Thermostats that activate cycling are usually readily accessible to the user, but the sensors that respond to compartment conditions must be in the ____________.

d. The ____________ temperature control will usually be located in the top of the fresh-food compartment or at the top of the back or side of the fresh-food compartment.

e. Some thermostats have a sensor fastened directly to the ____________, but the sensor on many thermostats will be located to sense the air in the compartment.

f. Some appliances use a small heater called an ambient ____________ to heat up the air around the thermostat sensor to cause the thermostat to cycle properly when the appliance is located in an area where the ambient temperature is lower than the desired cabinet temperature.

g. On self-defrosting refrigerator-freezers, a temperature control with a ____________- may be used to allow sufficient time for frost removal.

4. Complete statements about compressor start components. Write in the word(s) that best completes each of the following statements.

   a. Compressor motors on most domestic refrigerated appliances are ____________-____________ motors which require additional start components which will be located on or near the compressor.

   b. Split-phase motors require a ____________ relay to disengage the start windings and the start capacitor, if present, when the compressor motor reaches an operating speed.

   c. Split-phase motor relays include:

      1) ____________-____________ current relays.

      2) ____________-____________-____________ current relays.

      3) ____________-____________ starting relays.

   d. A start ____________ is usually an optional item which is added when the compressor motor has trouble starting.

   e. Compressor motors will also have an overload which may be built into the windings or located on the outside of the compressor shell; the overload prevents damage to the compressor in cases of ____________ temperature and/or current.

Written Test

5. Solve problems about air flow. Circle the number in front of the item that best solves each of the following problems.

   a. You are troubleshooting an older refrigerator and find that the schematic for the appliance doesn't show the location of any kind of fan. You need to:

      1) assume the schematic is wrong and troubleshoot until you find a fan.

      2) realize that you are working with a natural convection appliance that is utilizing the principle that cooler air falls and warmer air rises.

   b. As you open the fresh food compartment door on a refrigerator-freezer you are preparing to work on, you hear the noise of a fan continuing to run. You should know immediately that the problem probably is:

      1) in the push-button switch in the door moulding because the fan should go off when the door is opened.

      2) in the fan relay which has obviously failed.

   c. On a refrigerator-freezer, you suspect that air movement in the appliance is not right, but the fan in the appliance seems to be working properly. To solve the problem, you should:

      1) remove and check the fan motor.

      2) check out dampers and ducts used to channel air to specific areas: they may be stuck, broken, or have some other problem.

6. Select true statements about controls and conditions for major compartments. Place an "X" beside each true statement.

_______ a. The simplest refrigerated appliances such as small chest-type freezers have only one compartment while deluxe model refrigerator-freezers may have eight or more compartments.

_______ b. Freezer controls are normally set to maintain a temperature range of 10° to 30°F while fresh-food compartment controls are set to maintain a range from 40° to 48°F.

_______ c. Temperature in a freezer is normally controlled by a single thermostat which has its sensor placed in contact with the condenser.

_______ d. In small refrigerator-freezers, the freezer compartment may be only a small compartment in the fresh food compartment and the control for both is a single thermostat.

_______ e. Larger two-door refrigerator-freezers have separate freezer and fresh-food compartments with the thermostat located in either compartment while the control in the other compartment is a damper which controls air flow between the two compartments.

Written Test

________ f. Take caution in adjusting refrigerator-freezer controls because when you adjust either control, you change temperatures in both compartments.

7. Complete statements about controls and conditions for compartments within compartments. Write in the word(s) that best completes each of the following statements.

   a. Maintaining different conditions in a compartment within a major compartment requires controlling the air to that compartment with an adjustable damper or separating the small compartment from the major compartment with a ____________.

   b. Freezer or freezer compartments may contain a ____________ - ____________ compartment or shelf to lower temperatures quickly when food is first placed in the freezer.

   c. Slightly lower temperatures are maintained in the fast-freeze area by locating the area near the beginning of the ____________ or directing air with a duct or damper from the beginning of the evaporator to the fast-freeze area.

   d. The ice trays or the ice maker are always located in the ____________ - ____________ area in a refrigerator-freezer so that ice can be produced as quickly as possible.

   e. Smaller compartments within the fresh-food compartment may use ____________ located around the compartment or in the air duct to the compartment to keep processed meat, cheese, butter, and other foods at slightly warmer temperatures, or achieve the same objective just by separating these foods from the rest of the compartment.

   f. Other compartments within the fresh-food compartment keep meat and some vegetables at slightly ____________ temperatures by using the same technique as that in the fast-freeze area; ducts or dampers direct air from the beginning of the evaporator into those compartments.

   g. ____________ is lowered in a compartment by using a heater, and humidity is raised in a compartment by locating it at the bottom of the fresh-food compartment.

   h. A ____________ heater in the door or cabinet hear the gaskets controls sweating around cabinet gaskets and a mullion heater in the mullion strip controls sweating on the mullion strip.

   i. Some refrigerator-freezers have an energy-saving switch to turn off perimeter and/or mullion heaters when ambient air humidity is ____________.

Written Test

8. Controlling frost and ice accumulation

   a. Frost and ice accumulation on the ____________ and at some other locations must be avoided or removed.

   b. Frost and ice accumulation can be removed by manually or automatically turning off the appliance periodically and allowing the frost and ice to melt or by adding ____________ to speed the process.

   c. Appliances with ice makers sometimes have ____________ - ____________ ____________ around the water inlet tube to prevent the water in the tube from freezing.

   d. Some appliances have an air duct heater inside the duct between the freezer and another compartment to prevent ice from blocking ____________ - ____________ .

   e. A drain ____________ heater is sometimes used to prevent water from freezing as it runs out of the drain trough into a tube which carries the water to a pan beneath the appliance.

   f. Automatic defrosting can be accomplished by using electric resistance heaters for electric defrost or by routing hot ____________ refrigerant through the evaporator for hot gas defrost.

   g. In both types of automatic defrosting, a timed control initiates the ____________ ____________ before frost can accumulate.

   h. Self-defrosting or automatically defrosting appliances may cost more to operate, but most people find the ____________ worth the extra cost.

9. Complete statements about electric defrost. Write in the word(s) that best completes each of the following statements.

   a. The electric defrost cycle is initiated by a motor-driven timer or an electronic timer which is usually located ____________ the appliance.

   b. Various manufacturers use timers with different defrost cycles, but defrost timer motor running time is either ____________ or determined by compressor running time.

   c. The timer calls for defrost after a set number of hours of timer motor ____________ time.

Written Test

d. The termination thermostat must sense a ____________ enough temperature to require defrosting before defrosting will start.

e. The termination thermostat sensor is attached to the final section of evaporator tubing where frost accumulates ____________.

f. The defrost ____________ which is located under the evaporator or embedded in the evaporator fins will be energized when both the timer motor contacts and termination thermostat contacts are closed.

g. After frost has melted and defrost termination thermostat sensor has warmed sufficiently, the defrost ____________ thermostat contacts will open and turn off the defrost heater.

h. The defrost ____________ thermostat is set to prevent ambient temperature around the evaporator from rising about 45° to 50°F.

i. Even if frost accumulation is not completely removed, the timer motor contacts will open after a set number of minutes to prevent temperatures from rising too high in the ____________.

j. At the same time the timer opens contacts to the defrost heater, it closes contacts to the compressor motor which will start if the primary temperature control is calling for ____________.

k. If the unit has a ____________ - ____________ heater, it will be wired parallel to the defrost heater and termination thermostat circuits and will stay on for the time of the entire defrost cycle.

10. Select true statements about heat gas defrost. Place an "X" beside each true statement.

_______ a. The hot gas defrost cycle is initiated by a motor-driven timer, an electronic timer, or a ratchet timer which is usually located underneath the appliance.

_______ b. The motor-driven timer and electronic timer operate for hot gas defrost the way they operate for electric defrost.

_______ c. The ratchet timer advances with each opening and closing of the freezer door.

_______ d. The ratchet timer may include a remote sensing bulb for termination of defrost instead of a separate defrost termination thermostat.

_______ e. The hot gas defrost cycle works like the electric defrost cycle except a bypass solenoid valve is energized instead of the electric defrost heater.

_______ f. The hot gas bypass valve controls the flow of refrigerant in a tube which is connected to the discharge line.

Written Test

_______ g. When the solenoid is energized, the valve opens and directs hot discharge refrigerant into the evaporator to effect frost removal.

Permission to duplicate this test is granted.

Electrical Components and Control Devices
Unit 3

Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Assignment Sheet 1—Identify Heater Circuits on a Schematic Rating ______

Comments:

Assignment Sheet 2—Identify Controls on a Schematic Rating ______

Comments:

Job Sheet 1—Replace a Temperature Control Rating ______

Comments:

Job Sheet 2—Replace a Defrost Heater Rating ______

Comments:

Other:

Written Tests: ________ Pretest ________ Posttest ________

Total ________

Teacher Signature ______________________ Date __________

Student Signature ______________________ Date __________

Permission to duplicate this form is granted.

Electrical Components and Control Devices
Unit 3

Information Sheet

1. **Terms and definitions**

   a. **Defrost**—Removing frost and ice accumulation from an evaporator and other areas where frost and ice accumulate

   b. **Perimeter**—That part of an appliance cabinet around a compartment door opening

   c. **Range**—The difference between the cut-in and cut-out settings of a control

   d. **Sweating**—Moisture accumulation on cabinet walls or other locations which takes place during high humidity conditions in ambient air

   e. **Termination**—The stopping of a cycle or a function

2. **Objectives of electrical components and control devices**

   a. In refrigerators and freezers, desired temperature and humidity are maintained using electrical components to control air flow, and/or add heat at selected locations in various compartments of refrigerators and freezers.

   b. Most electrical components in a refrigerated appliance accomplish work or control those components that accomplish work.

   Example: The compressor motor is the electrical component that accomplishes work; the compressor is controlled by an electrical component called a thermostat.

   c. Electrical components may also be used to control frost accumulation in refrigerated appliances.

   d. How the electrical components relate to each other is shown on one or more electrical diagrams which accompany each appliance.

   e. Other control devices usually are some type of damper to control air flow and are operated manually or by a mechanical temperature control.

3. **Temperature controls**

   a. Temperature controls, also called thermostats or cold controls, start and stop the compressor motor or one or more heaters in response to changing temperatures in the compartments.

   Note: Reference line 9 on the ladder schematic in Student Supplement 1.

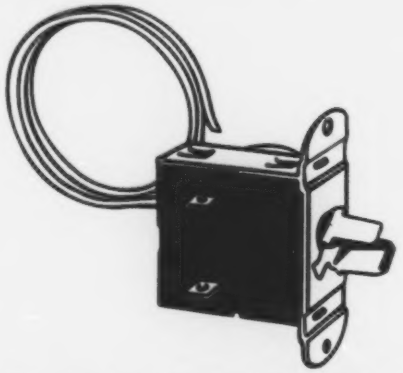
Information Sheet

b. Temperature controls may also be used to stop and start fans or open and close dampers.

c. Thermostats that activate cycling are usually readily accessible to the user, but the sensors that respond to compartment conditions must be in the compartment.

Note: There may be more than one control in a compartment.

d. The primary temperature control will usually be located in the top of the fresh-food compartment or at the top of the back or side of the fresh-food compartment.



Temperature Control Thermostat

e. Some thermostats have a sensor fastened directly to the evaporator, but the sensor on many thermostats will be located to sense the air in the compartment.

f. Some appliances use a small heater called an ambient compensator to heat up the air around the thermostat sensor to cause the thermostat to cycle properly when the appliance is located in an area where the ambient temperature is lower than the desired cabinet temperature.

Note: Reference line 8 on the ladder schematic in Assignment Sheet 1.

g. On self-defrosting refrigerator-freezers, a temperature control with a wide range may be used to allow sufficient time for frost removal.

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Information Sheet

4. Compressor start components

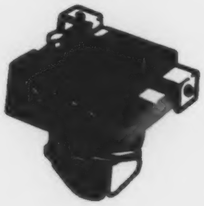
a. Compressor motors on most domestic refrigerated appliances are split-phase motors which require additional start components which will be located on or near the compressor.

b. Split-phase motors require a start relay to disengage the start windings and the start capacitor, if present, when the compressor motor reaches an operating speed.

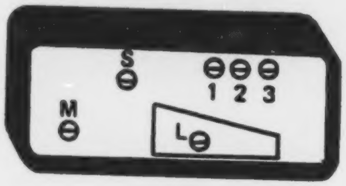
Note: Reference line 10 of the ladder schematic in Assignment Sheet 1.

c. Split-phase motor relays include:

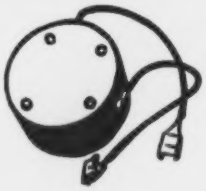
1) Coil-type current relays.



2) Hot-wire-type current relays.



3) Solid-state starting relays.



d. A start capacitor is usually an optional item which is added when the compressor motor has trouble starting.

e. Compressor motors will also have an overload which may be built into the windings or located on the outside of the compressor shell; the overload prevents damage to the compressor in cases of excessive temperature and/or current.

Information Sheet

5. Air flow

a. Maintaining the same temperature throughout a compartment, or different temperatures in different compartments, requires control of air movement through the appliance.

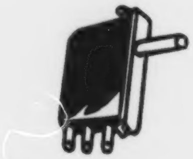
b. To circulate air, the simplest design is natural convection which uses the tendency of cooler air to fall and warmer air to rise.

c. Forced air designs use one or more fans to circulate air within a compartment or from one compartment to another.

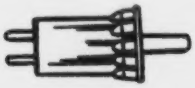
d. Since a fan that continues running after a compartment door is opened draws warmer air into the compartment, a push-button switch activated by opening the door usually stops the fan.

Note: Reference line 9 of the ladder schematic in Assignment Sheet 1.

e. The fan switch may have two sets of contacts, a normally open set to turn the fan on when the door is closed, and a normally closed set that turns the light on when the door is opened.



f. The fan switch and light switch may also be two separate switches.



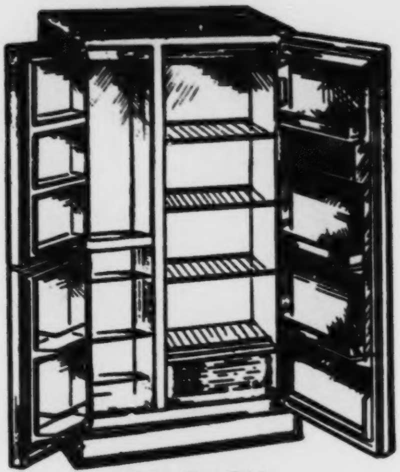
g. Turning fans on/off does not necessarily move the proper amount of air to the right places so a system of ducts and dampers is often used to divert the proper amount of air to the right places.

h. Dampers may be manually controlled or controlled with a mechanical thermostat.

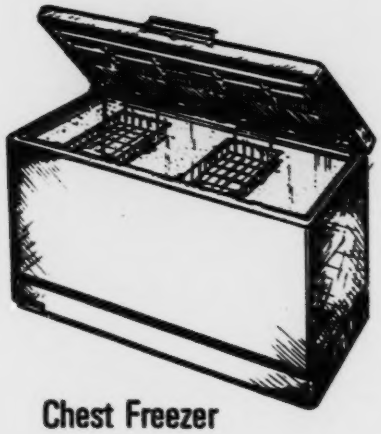
6. Controls and conditions for major compartments

a. The simplest refrigerated appliances such as small chest-type freezers have only one compartment while deluxe model refrigerator-freezers may have eight or more compartments.

Information Sheet



Side-By-Side
Refrigerator-Freezer

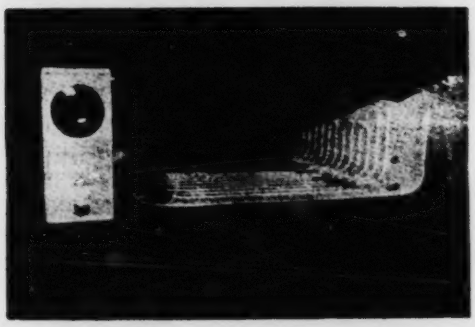


Chest Freezer

b. Freezer controls are normally set to maintain a temperature range of 0° to 10°F while fresh-food compartment controls are set to maintain a range from 34° to 38°F.

c. Temperature in a freezer is normally controlled by a single thermostat which has its sensor placed in contact with the evaporator.

d. In small refrigerator-freezers, the freezer compartment may be only a small compartment in the fresh food compartment and the control for both is a single thermostat.



e. Larger two-door refrigerator-freezers have separate freezer and fresh-food compartments with the thermostat located in either compartment while the control in the other compartment is a damper which controls air flow between the two compartments.

Information Sheet

Example of freezer control using mechanical damper

f. Take caution in adjusting refrigerator-freezer controls because when you adjust either control, you change temperatures in both compartments.

7. Controls and conditions for compartments within compartments

a. Maintaining different conditions in a compartment within a major compartment requires controlling the air to that compartment with an adjustable damper or separating the small compartment from the major compartment with a door.

b. Freezer or freezer compartments may contain a fast-freeze compartment or shelf to lower temperatures quickly when food is first placed in the freezer.

c. Slightly lower temperatures are maintained in the fast-freeze area by locating the area near the beginning of the evaporator or directing air with a duct or damper from the beginning of the evaporator to the fast-freeze area.

d. The ice trays or the ice maker are always located in the fast-freeze area in a refrigerator-freezer so that ice can be produced as quickly as possible.

e. Smaller compartments within the fresh-food compartment may use heaters located around the compartment or in the air duct to the compartment to keep processed meat, cheese, butter, and other foods at slightly warmer temperatures, or achieve the same objective just by separating these foods from the rest of the compartment.

f. Other compartments within the fresh-food compartment keep meat and some vegetables at slightly lower temperatures by using the same technique as that in the fast-freeze area; ducts or dampers direct air from the beginning of the evaporator into those compartments.

g. Humidity is lowered in a compartment by using a heater, and humidity is raised in a compartment by locating it at the bottom of the fresh-food compartment.

BEST COPY AVAILABLE

Information Sheet

h. A perimeter heater in the door or cabinet hear the gaskets controls sweating around cabinet gaskets and a mullion heater in the mullion strip controls sweating on the mullion strip.

Note: A perimeter heater may also be called a "dew point" or "cabinet heater." Reference lines 2 and 3 of the ladder schematic in Assignment Sheet 1.

i. Some refrigerator-freezers have an energy-saving switch to turn off perimeter and/or mullion heaters when ambient air humidity is low.

Note: Manufacturers call the above switch by different names and have directions for its use depending on local temperature and humidity. Reference line 2 on the ladder schematic in Assignment Sheet 1.

8. Controlling frost and ice accumulation

a. Frost and ice accumulation on the evaporator and at some other locations must be avoided or removed.

b. Frost and ice accumulation can be removed by manually or automatically turning off the appliance periodically and allowing the frost and ice to melt or by adding heat to speed the process.

Caution: Do not use a sharp object to remove frost and ice accumulation because there is a great potential for poking holes in the evaporator or other tubing.

c. Appliances with ice makers sometimes have a fill-tube heater around the water inlet tube to prevent the water in the tube from freezing.

d. Some appliances have an air duct heater inside the duct between the freezer and another compartment to prevent ice from blocking air flow.

e. A drain trough heater is sometimes used to prevent water from freezing as it runs out of the drain trough into a tube which carries the water to a pan beneath the appliance.

f. Automatic defrosting can be accomplished by using electric resistance heaters for electric defrost or by routing hot discharge refrigerant through the evaporator for hot gas defrost.

g. In both types of automatic defrosting, a timed control initiates the defrost cycle before frost can accumulate.

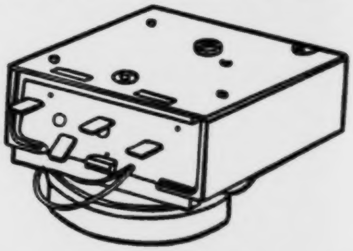
h. Self-defrosting or automatically defrosting appliances may cost more to operate, but most people find the convenience worth the extra cost.

Information Sheet

9. Electric defrost

a. The electric defrost cycle is initiated by a motor-driven timer or an electronic timer which is usually located underneath the appliance.

Note: Reference lines 5, 6, and 7 on the ladder schematic in Assignment Sheet 1.



b. Various manufacturers use timers with different defrost cycles, but defrost timer motor running time is either continuous or determined by compressor running time.

c. The timer calls for defrost after a set number of hours of timer motor run time.

d. The termination thermostat must sense a low enough temperature to require defrosting before defrosting will start.

Note: Reference line 6 on the ladder schematic in Assignment Sheet 1.

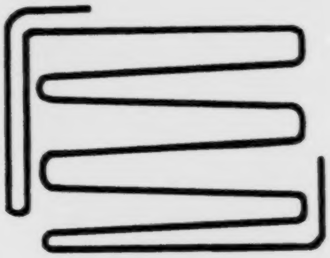
e. The termination thermostat sensor is attached to the final section of evaporator tubing where frost accumulates first.

Note: Some units use more than one termination thermostat.

Information Sheet

f. The defrost heater which is located under the evaporator or embedded in the evaporator fins will be energized when both the timer motor contacts and termination thermostat contacts are closed.

Note: Reference line 6 on the ladder schematic in Assignment Sheet 1.



Tube-type defrost heater

Quartz-type defrost heater

g. After frost has melted and defrost termination thermostat sensor has warmed sufficiently, the defrost termination thermostat contacts will open and turn off the defrost heater.

h. The defrost termination thermostat is set to prevent ambient temperature around the evaporator from rising about 45° to 50°F.

i. Even if frost accumulation is not completely removed, the timer motor contacts will open after a set number of minutes to prevent temperatures from rising too high in the compartments.

j. At the same time the timer opens contacts to the defrost heater, it closes contacts to the compressor motor which will start if the primary temperature control is calling for cooling.

Note: Reference lines 5, 6, and 7 on the ladder schematic in Assignment Sheet 1.

k. If the unit has a drain-trough heater, it will be wired parallel to the defrost heater and termination thermostat circuits and will stay on for the time of the entire defrost cycle.

Note: Reference line 7 on the ladder schematic in Student Supplement 1.

Information Sheet

10. Hot gas defrost

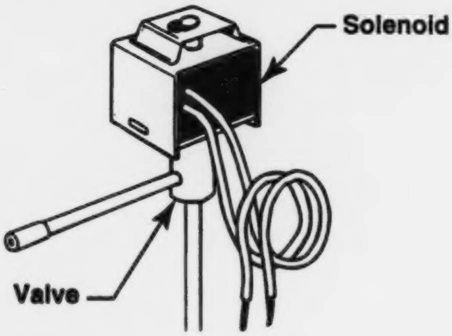
a. The hot gas defrost cycle is initiated by a motor-driven timer, an electronic timer, or a ratchet timer which is usually located underneath the appliance.

b. The motor-driven timer and electronic timer operate for hot gas defrost the way they operate for electric defrost.

c. The ratchet timer advances with each opening and closing of the freezer door.

d. The ratchet timer may include a remote sensing bulb for termination of defrost instead of a separate defrost termination thermostat.

e. The hot gas defrost cycle works like the electric defrost cycle except a bypass solenoid valve is energized instead of the electric defrost heater.



f. The hot gas bypass valve controls the flow of refrigerant in a tube which is connected to the discharge line.

g. When the solenoid is energized, the valve opens and directs hot discharge refrigerant into the evaporator to effect frost removal.

Electrical Components and Control Devices
Unit 3

Assignment Sheet 1—Identify Heater Circuits on a Schematic

Name ______________________________ Overall Rating __________

Evaluation Criteria	**Rating**
Number of identifications attempted	______
Number of identifications properly made	______

Directions: List four types of heater circuits shown in the schematic that accompanies this assignment sheet.

Hint: A circuit consists of a power source, connecting wiring, a load, and usually a control.

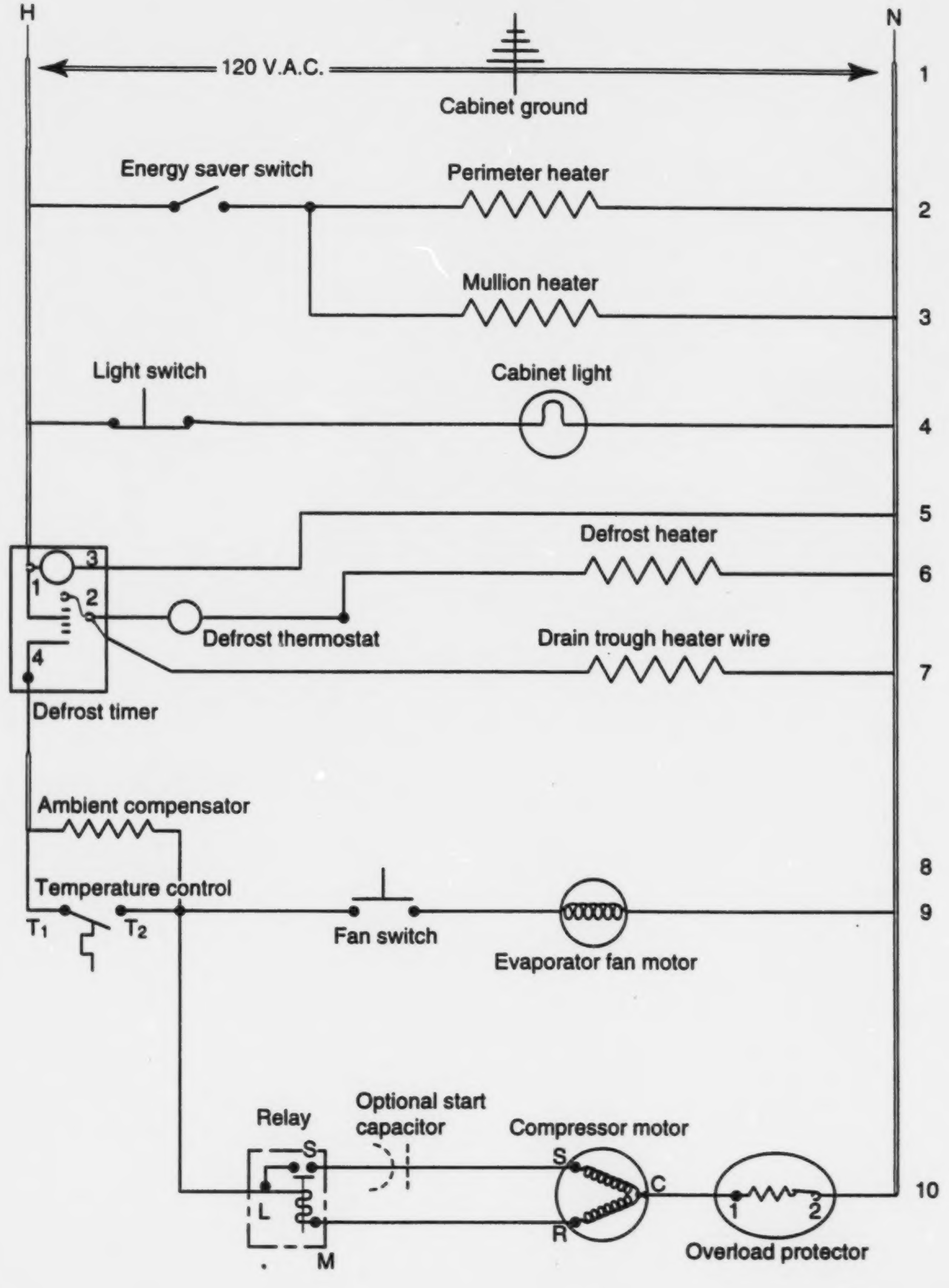
a. ____

b. ____

c. ____

d. ____

Assignment Sheet 1


H
N
120 V.A.C.
Cabinet ground
1
Energy saver switch
Perimeter heater
2
Mullion heater
3
Light switch
Cabinet light
4
5
Defrost heater
6
3
1
2
4
Defrost thermostat
Drain trough heater wire
7
Defrost timer
Ambient compensator
8
Temperature control
T₁
T₂
Fan switch
Evaporator fan motor
9
Relay
S
L
M
Optional start capacitor
Compressor motor
S
C
R
1
2
Overload protector
10

Electrical Components and Control Devices
Unit 3

Assignment Sheet 2—Identify Controls on a Schematic

Name ______________________________ Overall Rating ______________

Evaluation Criteria	**Rating**
Number of identifications attempted	______
Number of identifications properly made	______

Directions: List seven controls shown in the schematic that accompanies this assignment sheet.

a. ______________________________

b. ______________________________

c. ______________________________

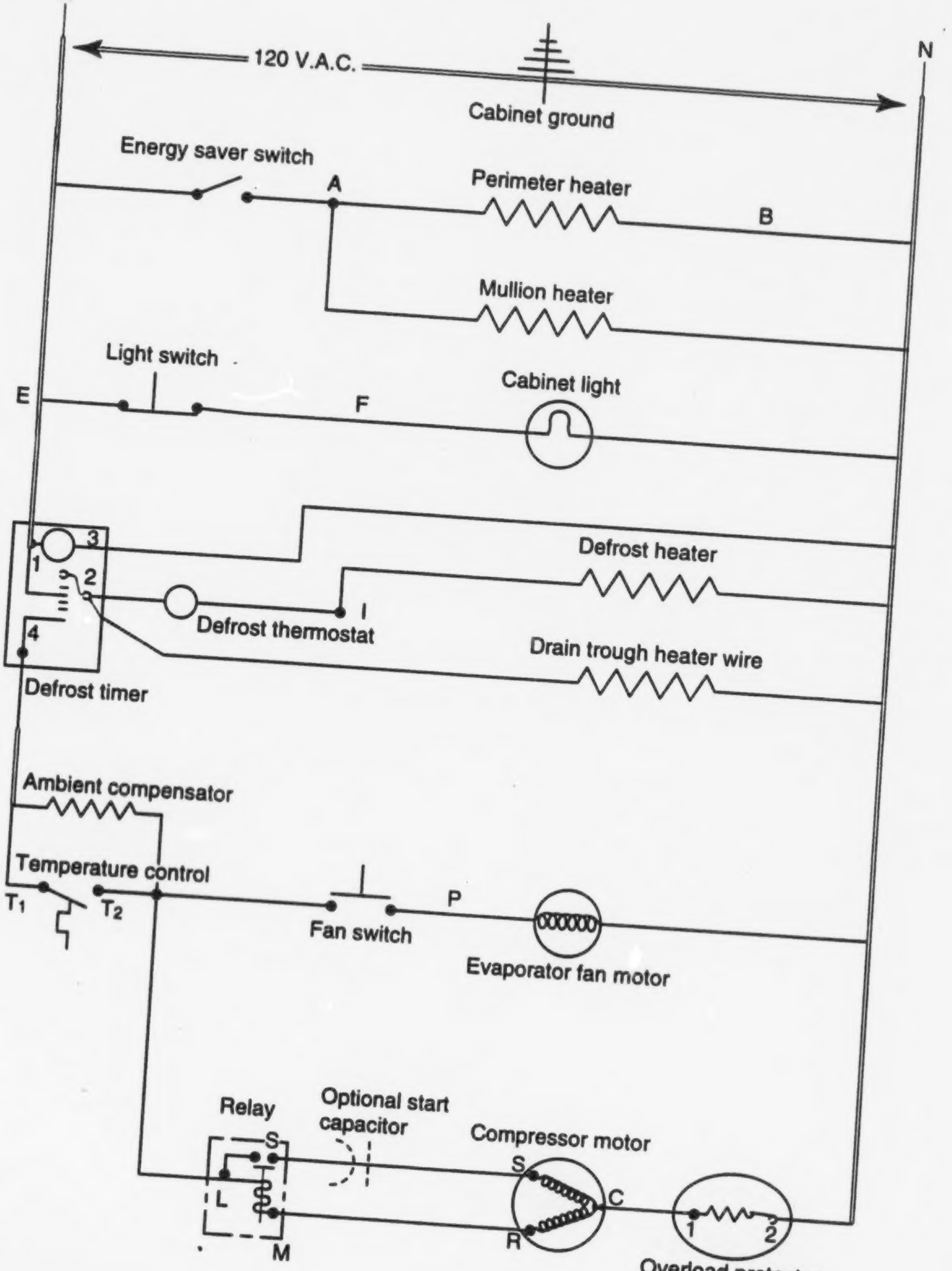
d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

Assignment Sheet 2


H
120 V.A.C.
N
Cabinet ground
Energy saver switch
A
Perimeter heater
B
Mullion heater
Light switch
E
F
Cabinet light
3
1
2
4
Defrost heater
Defrost thermostat
I
Drain trough heater wire
Defrost timer
Ambient compensator
Temperature control
T1
T2
Fan switch
P
Evaporator fan motor
Relay
Optional start capacitor
Compressor motor
S
L
M
S
C
R
1
2
Overload protector

Electrical Components and Control Devices
Unit 3

Job Sheet 1—Replace a Temperature Control

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
Old temperature control and sensor properly removed	______
New temperature control and sensor properly installed	______
Minimum 24-hour recorder check verifies proper cycling	______

A. Tools and materials

Refrigerator or freezer as selected by instructor
Appropriate service literature
Appropriate hand tools
Replacement temperature control w/literature
Temperature recorder
Clean shop cloth
Container for ice and ice cube supply
Ohmmeter
Recording thermometer
Safety glasses
Service Work Order

B. Procedure

☐ 1. Consult customer/instructor for special information that may affect servicing.

☐ 2. Obtain manufacturer's operating instructions or troubleshooting information, if available.

☐ 3. Put on safety glasses.

☐ 4. Disconnect electrical power from the refrigerator.

☐ 5. Remove the knob from the temperature control.

Note: The knob should be easy to remove, but if it isn't, don't pry on it; some controls have the center part of the knob on a threaded shaft and that will have to be removed first.

☐ 6. Remove the temperature control mounting screws.

Job Sheet 1

☐ 7. Pull the control out far enough to disconnect electrical leads.

☐ 8. Disconnect the sensing element from the evaporator if it is attached to the evaporator.

☐ 9. Carefully remove the sensing element without kinking or bending it.

Note: Complete steps 10 through 14 to be sure the temperature control needs to be replaced.

☐ 10. Immerse the control you removed in a container of melting ice.

☐ 11. Connect an ohmmeter to the electrical terminals.

☐ 12. After 30 seconds or more, turn the dial up and down and note at what point continuity changes by observing changes in the ohmmeter readings.

☐ 13. Look for continuity to change in the upper end of the range of settings to indicate that the temperature control is operating properly.

☐ 14. If continuity changes at any other places, the control is probably not functioning properly and should be replaced; check with your instructor before proceeding.

☐ 15. Use the following procedure to remount the original control or to replace the control with a new one; both procedures are the same.

☐ 16. Straighten the sensing element on the temperature control you are installing.

☐ 17. Insert the sensing element and be careful not to kink or break it.

☐ 18. Attach the electrical leads to the control.

☐ 19. Place control in the proper location.

☐ 20. Replace the mounting screws.

☐ 21. Attach the sensing element in the same place where the original element was removed.

☐ 22. If the sensing element touches the evaporator, check to make sure the sensing element touches only the intended point; if the element touches any other spot it will cause erratic cycling.

☐ 23. Replace control knob.

☐ 24. Have your instructor check your installation.

☐ 25. Plug in the refrigerator.

Job Sheet 1

☐ 26. Set temperature control at mid range.

☐ 27. Place temperature recorder or remote sensor in refrigerator cabinet.

☐ 28. Allow the refrigerator to run for 24 hours.

☐ 29. Check the recorder chart for cycling pattern.

☐ 30. Complete your Service Work Order, except for pressure readings.

☐ 31. Have your instructor check your cycling chart.

☐ 32. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

____

____

ACRD-71

Job Sheet 1

Service Work Order

Customer's Name ______________________________

Customer's Address ______________________________

Brief description of problem ______________________________

____

____

Time and date service or repair started ______________________________

Time and date service or repair ended ______________________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ______________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ______________

What amount of refrigerant was added? ______________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type? ________ Amount? ______

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ______________________ Date ______________

Job Sheet 1

Service Work Order

Evaluation of unit condition and general performance:

____

____

____

____

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
e. Liquid line pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
f. Evaporator temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
g. Other compartment temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
h. Condenser air temperatures at end of cycle	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
i. Additional information			
j. Additional information			
k. Technician signature ______________ Date ________			

Electrical Components and Control Devices
Unit 3

Job Sheet 2—Replace a Defrost Heater

Name ______________________ Attempt Number ________

Date ______________________ Overall Rating ________

Evaluation Criteria	Rating
Old defrost heater properly removed	______
New defrost heater properly installed	______
Ammeter check properly made	______
Defrost cycle timed for verification	______

A. Tools and materials

Refrigerator or freezer as selected by instructor
Appropriate service literature
Appropriate hand tools
Replacement defrost heater w/literature
Ammeter or wattmeter and ohmmeter
Clean shop cloth
Safety glasses
Service Work Order

B. Procedure

☐ 1. Consult customer/instructor for special information that may affect servicing.

☐ 2. Obtain manufacturer's operating instructions or troubleshooting information, if available.

☐ 3. Put on safety glasses.

☐ 4. Disconnect electrical power from the refrigerator.

☐ 5. Open freezer compartment door.

☐ 6. Allow freezer compartment to warm up.

☐ 7. Clean moisture from the freezer compartment as required.

☐ 8. Remove evaporator cover panel.

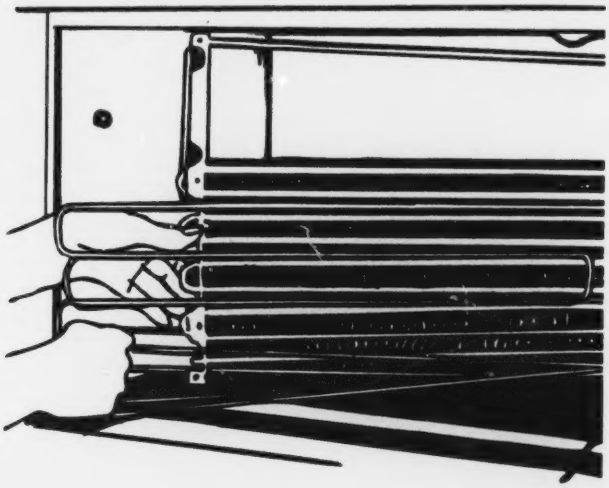
Job Sheet 2

☐ 9. Remove the screws from the evaporator mounting brackets.

☐ 10. Carefully pull the evaporator out far enough that you can access the defrost heater.

☐ 11. Disconnect the defrost heater electrical wires, or cut the wires if necessary.

☐ 12. Remove the heater from the evaporator, and if it is a finned evaporator, be careful not to bend the fins.



☐ 13. Use an ohmmeter to check the continuity of the heater you removed.

☐ 14. If you read continuity, check manufacturer's literature or ask your supervisor/instructor what the resistance reading should be for the type of heater you are checking.

☐ 15. If the resistance reading is correct, the heater may be reinstalled in the appliance.

☐ 16. If the resistance reading is incorrect, you need to install a new heater.

Note: It is good practice to check a new heater before you install it to make sure you have not received a defective heater or one that has been damaged in shipment.

☐ 17. Use the following procedure to replace the original heater or to install a new heater; both procedures are the same.

☐ 18. Install the defrost heater in the evaporator slots, but do not use a screwdriver to push the defrost heater into the slots.

Note: If you will flatten one end of a piece of 1/2" o.d. copper tubing and make a V cut in it, you'll have a good defrost heater installation tool.

☐ 19. Connect the electrical wires to the defrost heater.

Job Sheet 2

☐ 20. Check to make sure that no wiring is touching the heater.

☐ 21. Place evaporator back into position.

☐ 22. Replace evaporator mounting screws.

☐ 23. Have your instructor check your installation.

☐ 24. Replace the evaporator cover panel.

☐ 25. Plug in the refrigerator.

☐ 26. Set temperature control at coldest setting.

☐ 27. Allow the refrigerator to run long enough to cool down the termination thermostat.

☐ 28. Set the ammeter for its highest scale.

☐ 29. Place the ammeter around one conductor of the power cord.

☐ 30. Turn the timer shaft in a clockwise direction until you hear the first click.

☐ 31. Check the ammeter reading and record it here: ______________________.

☐ 32. Set the ammeter for a center scale reading.

☐ 33. Observe the ammeter for a reduction in reading when the termination thermostat opens, and record the reading here: ______________________.

☐ 34. Check the length of time of the defrost cycle and record it here: __________.

Note: The defrost cycle should run no longer than 25 minutes.

☐ 35. Complete your Service Work Order except for pressure readings.

☐ 36. Have your instructor check all your readings.

☐ 37. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ____

____

____

Job Sheet 2

Service Work Order

Customer's Name ______________________________

Customer's Address ______________________________

Brief description of problem ______________________________

____

____

Time and date service or repair started ______________________________

Time and date service or repair ended ______________________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ______________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ______________

What amount of refrigerant was added? ______________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type?________ Amount? ______

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ______________ Date ______________

Job Sheet 2

Service Work Order

Evaluation of unit condition and general performance:

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
e. Liquid line pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
f. Evaporator temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
g. Other compartment temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
h. Condenser air temperatures at end of cycle	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
i. Additional information			
j. Additional information			

k. Technician signature ______________________ Date ____________

Refrigerator and Freezer Service and Repair
Unit 4

Objective Sheet

Unit Objective

After completing this unit, the student should be able to remove and replace breaker trim, replace evaporator and condenser fan motors, replace a liquid-line drier, charge a small, refrigerated appliance, repair leaks in aluminum evaporators with brazing and with epoxy, check the efficiency of a compressor, and replace a compressor. The student should demonstrate these competencies by completing the assignment and job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to service and repair with their correct definitions.
2. Complete statements about the general procedure for service.
3. Solve problems about gathering information about the equipment and type of service.
4. Select true statements about evaluating equipment condition.
5. Select true statements about investigating possible causes of problems.
6. Complete statements about determining actual causes of problems.
7. Select true statements about servicing appliance cabinets.
8. Solve problems about servicing electrical components.
9. Complete statements about replacing electrical components.
10. Solve problems about servicing refrigeration components.
11. Complete statements about repairing refrigerant leaks.
12. Select true statements about safety while replacing refrigeration components.
13. Solve problems about servicing capillary tubes.
14. Select true statements about replacing compressors.

Objective Sheet

15. Use a troubleshooting guide to find possible causes of customer complaints. (Assignment Sheet 1)

16. Diagnose circuit problems using a schematic. (Assignment Sheet 2)

17. Select filter-driers for given applications. (Assignment Sheet 3)

18. Select compressors for given applications. (Assignment Sheet 4)

19. Perform maintenance on a refrigerator or freezer. (Job Sheet 1)

20. Remove and replace breaker trim. (Job Sheet 2)

21. Troubleshoot selected problems with a refrigerator or freezer. (Job Sheet 3)

22. Check the efficiency of a compressor. (Job Sheet 4)

23. Replace an evaporator fan motor. (Job Sheet 5)

24. Replace a condenser fan motor. (Job Sheet 6)

25. Install a process tube adapter on a refrigerator or freezer. (Job Sheet 7)

26. Repair a leak in an aluminum evaporator using paste epoxy. (Job Sheet 8)

27. Repair a leak in an aluminum evaporator using a pre-mixed, two-part epoxy stick. (Job Sheet 9)

28. Repair a hole in an aluminum evaporator by brazing. (Job Sheet 10)

29. Make an aluminum-to-aluminum or an aluminum-to-copper swage joint. (Job Sheet 11)

30. Replace a liquid-line filter-drier. (Job Sheet 12)

31. Charge a small, refrigerated appliance using a charging cylinder. (Job Sheet 13)

32. Charge a small, refrigerated appliance using charging scales. (Job Sheet 14)

33. Service a capillary tube. (Job Sheet 15)

34. Replace a compressor. (Job Sheet 16)

Refrigerator and Freezer Service and Repair
Unit 4

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction or individual learning activities. Study the specific objectives to determine the order in which you will present the objectives.
2. Review Teaching Suggestions section that follows. Plan for classroom activities.
3. Plan enrichment of exceptional students as well as accommodation of special needs students.
4. Add graphic materials or overhead transparencies as needed.
5. Develop teaching plan. Adjust for different learning styles.
6. Make copies of the Unit Evaluation Form.

Delivery and Application

7. Provide students with unit of instruction.
8. Discuss unit and specific objectives.
9. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic skills when applicable.
10. Discuss the assignment and job sheets, and demonstrate the job sheets. Review criteria for evaluation of the activity.

Evaluation

11. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
12. Make copies of the written test. Add or modify test items as needed.
13. Give written test.
14. Compile assignment sheet ratings, job sheet ratings, and written test scores on the Unit Evaluation Form. Include any additional assignment or job sheets.
15. Reteach and retest as required.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the Teaching Suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: a SCANS Report for America 2000.* These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

1. Have a technician who specializes in refrigerator-freezer repair talk to the class about general problems with appliances, specific problems that the technician has confronted and solved, and special or unusual problems that technicians have to deal with. Skill areas: **Basic skills, listening.**
2. Invite the same or similar person as referenced in item 1 to tell some personal war stories about dealings with customers, customer's children and pets, and other home or apartment conditions that turn service calls into adventures. Skill areas: **Basic skills, listening.**
3. Group students into teams so they can role play customer/service call technician. Have the customer prepare some basic complaints, and then have the service call technician make notes about the complaints. Have both role players report to the class so the class can compare the problems expressed by the customer with the notes made by the service technician. Skill areas: **Interpersonal skills, teamwork.**
4. Read the job sheets carefully, and prepare special materials that may be required. Job Sheet 4 requires the instructor to duplicate service work orders for students to use with different refrigerators or freezers. Purposely disable appliances selected for the activities in Job Sheet 4 so operating conditions will reflect typical customer complaints.
5. Student Supplement 1 and Assignment Sheet 1 are specifically designed to complement each other. And because the use of troubleshooting guides is so important to good service, the materials in Assignment Sheet 1 have been reproduced with answers in Teacher Supplement 1. After students have completed Assignment Sheet 1, hand out copies of the teacher supplement for students to use as continued reference.

Resources Used in Developing This Unit

1. Althouse, Andrew D. et al. *Modern Refrigeration and Air Conditioning.* South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.
2. *Sporlan Catch-All® Liquid Line and Suction Line Filter-Driers plus AK-1 and AK-3 Acid Test Kits, Bulletin 40-10.* St. Louis, MO: Sporlan Valve Company, 1991.
3. *The Air Conditioning, Heating, and Refrigeration News HVAC/R Source Guide.* Troy, MI: Business News Publishing Company, 1993.
4. *Valves and Accessories for Refrigeration and Air Conditioning Applications, Catalog 111C.* Melrose Park, IL: Henry Valve Company, 1993.

Suggested Activities

5. Wantiez, Gary W. *Air Conditioning and Refrigeration, Domestic Refrigeration.* Stillwater, OK: The Mid-America Vocational Curriculum Consortium, 1984.

6. Whitman, William C. and William M. Johnson. *Refrigeration & Air Conditioning Technology, 2nd ed.* Albany, NY: Delmar Publishers, Inc., 1991.

Suggested Supplemental Resources

1. **Maytag refrigerators/freezers:** Service manuals for Maytag refrigerators vary in cost from $5 to $20, and include ice maker information if the ice maker was installed at the Maytag factory. Some parts catalogs are also available. Call 615-478-6788.

2. **Frigidaire refrigerators/freezers:** Service manuals for Frigidaire refrigerators and freezers are usually available through local Frigidaire dealers, but general service assistance is available to the public through Frigidaire's "Product Advice Line." The product line also includes Tappan, Gibson, Kelvinator, and White-Westinghouse as well as Frigidaire. Call toll free 1-800-777-8349.

3. **General Electric refrigerators/freezers:** Service manuals for General Electric refrigerators and freezers are available through local GE dealers, but general service assistance is available to the public at GE's "Answer Center," at 1-800-626-2000.

4. **Whirlpool refrigerators/freezers:** Service manuals for various models cost from $12 to $16. Call the "Whirlpool Consumer Assistance Center" at 1-800-253-1301. Ask for the Parts Department.

5. For service literature and owner's manuals consult your local dealer for the brand name appliance for which you require information or assistance. Almost all local dealers have technical services available through a dealer hot line to the manufacturer. The local dealer may be your best source for difficult or unusual problems.

6. The Professional Development program from VICA is a sequence of activities designed specifically to help both secondary and postsecondary students learn specific employment skills and develop a positive attitude toward work. The professional development program stresses leadership skills, career planning, employment skills, civic activities, and on-the-job experiences. The professional development program is much more than a list that requires extra instructor time to properly correlate with other curriculum. The program has student workbooks with articulated activities that require student record keeping so that the program materials can be included in a portfolio or other materials significant beyond the classroom.

   If your program is not a member of VICA, the professional development program is a good vehicle to get you started. A special *VICA Professional Development Program Advisor's Guide* is available to steer instructors through programs for both secondary and postsecondary students. For information about VICA and the professional development program, call VICA at 703-777-8810, or write:

   Vocational Industrial Clubs of America
   Post Office Box 3000
   Leesburg, VA 22075

Suggested Activities

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

Refrigerator and Freezer Service and Repair
Unit 4

Answers to Assignment Sheets

Assignment Sheet 1

Scenario A:
1. Broken cold control
2. Broken defrost timer
3. Wires loose or broken
4. Broken external overload
5. Broken compressor (electrical problem)

Scenario B:
1. Broken start capacitor
2. Broken start relay
3. Broken compressor (electrical problem)
4. Broken compressor (stuck)
5. Restriction in refrigerant line

Scenario C:
1. Broken fan switch
2. Broken evaporator fan motor
3. Loose or broken wiring

Scenario D:
1. Dirty or obstructed condenser
2. Insufficient airflow around appliance
3. Outer shell or inner shell not sealed
4. Improper use

Scenario E:
1. Broken defrost timer
2. Broken defrost heater
3. Broken defrost heater thermostat
4. Loose or broken defrost circuit wiring

Scenario F:
1. Shortage of refrigerant
2. Compressor valves not holding

Scenario G:
1. Improper use
2. Controls not set properly
3. Broken airflow control
4. Broken airflow heater

Scenario H:
1. Improper use
2. Poor door seal
3. Controls not set properly
4. Light switch stuck closed
5. Outer or inner shell not sealed

Scenario I:
1. Airflow control not set properly
2. Broken airflow control
3. Air not able to get through air duct

Scenario J:
1. Broken cold control
2. Improperly positioned control sensor

Answers to Assignment Sheets

Scenario K:	1.	Controls not set properly
	2.	Improperly positioned control sensor
Scenario L:	1.	Broken cold control
	2.	Improperly positioned control sensor
Scenario M:	1.	Poor seals
	2.	Improper use
	3.	Improperly positioned control sensor
	4.	Improper refrigerant charge
Scenario N:	1.	Weak overload
Scenario O:	1.	Refrigerant tubing vibrating against other components
	2.	Loose components in contact with fan blade

Assignment Sheet 2, Part I

1. Why? To determine if voltage is available to the perimeter and mullion heaters.

   What? Voltage is available; energy saver switch is closed.

2. Why? To determine if the perimeter heater has continuity.

   What? The perimeter heater is open.

3. Why? To determine if source voltage is available to the light.

   What? Voltage is available, light is open.

4. Why? No good reason; in fact, checking across a switch with a voltmeter often gives a misleading reading.

   What? Nothing definite; too many possibilities present.

5. Why? To determine if defrost contacts to 2 are open or closed and if the timer is calling for defrost.

   What? Defrost contacts are closed and timer is calling for defrost.

6. Why? To determine if defrost thermostat is open or closed.

   What? Defrost thermostat is open.

7. Why? To determine if drain trough heater is working.

   What? Heater is working.

8. Why? To determine if defrost heater is sending power to other components by closing contacts to 4.

   What? Timer contacts are closed to 4.

Answers to Assignment Sheets

9. Why? To determine if thermostat contacts are closed or open (should be closed since box will be warm).

   What? Thermostat closed as it should be.

10. Why? To determine if fan switch is closed.

    What? Fan switch is open.

11. Why? To determine if voltage is available to compressor and if overload is closed.

    What? Overload is closed and voltage is getting to the compressor terminal box.

12. Why? To check run winding.

    What? Run winding is open.

Assignment Sheet 2, Part II

1. Light; replace bulb.
2. Fan switch; clean or replace.
3. Compressor; replace.
4. Defrost timer; replace if motor check shows motor not functioning

Assignment Sheet 3

1. C-032-F
2. So the cap tube can be inserted into it
3. A liquid-line filter with 3 cu. in. of dessicant and 3/8" solder connections
4. 1/4"
5. 2.1 oz.
6. 1.9 oz.
7. B-11-383
8. B-10-163
9. 1"

Assignment Sheet 4

1. a. B81-346 and B81-347
   b. 935
   c. 7 1/2" tall x 10 3/4" or 10 1/4" long
   d. Suction, 5/16"; discharge, 1/4"; process, 1/4"

2. a. B81-263
   b. 1/4 hp
   c. 4.50 amps

Refrigerator and Freezer Service and Repair
Unit 4

Answers to Written Test

1.
   a. 5
   b. 1
   c. 4
   d. 3
   e. 2

2.
   a. service
   b. condition
   c. possible
   d. actual
   e. service

3.
   a. 3)
   b. 2)

4. b, c, d, e, f

5. c, d, e

6.
   a. elimination
   b.
      1) source
      2) compressor
      3) fan
      4) timer
      5) wattmeter
   c. ohmmeter
   d. refrigeration
   e. operating conditions
   f. valve
   g. locations
   h. equalization
   i. Never

7. a, b, d, e, f, g, h

8.
   a. 1)
   b. 2)

9.
   a.
      1) poles
      2) contacts
      3) horsepower
      4) connections
      5) ratings
   b.
      1) dimensions
      2) diameter
      3) rotation
      4) fasteners

10.
   a. 3)
   b. 3)

Answers to Written Test

11. a. 1) steel
    2) hidden
    3) tight
    4) operating
    5) replacement
  b. epoxy
  c. mechanical
  d. brazing

12. a, b, c, d, e

13. a. 2)
  b. 1)

14. a. replaced
  b. 1) refrigerant line
    2) Btuh
    3) temperature
    4) compressor
    5) refrigerant
    6) oil
    7) accessories
  c. operating parameters
  d. electrical
  e. liquid line drier
  f. compressor

Refrigerator and Freezer Service and Repair
Unit 4

Written Test

Name ______________________ Date __________ Score __________

1. Match terms on the right with their correct definitions.

   _____ a. A total compressor failure usually resulting in overheating to such a degree that it poses a contamination problem to the entire system

   _____ b. Procedures performed at scheduled intervals to check and service critical components or conditions of a refrigerated appliance in order to minimize the need for repairs and maximize system performance

   _____ c. The company that manufactures the original appliance

   _____ d. Performing maintenance, troubleshooting, and/or repairs

   _____ e. A systematic approach to determine the cause(s) of component malfunctions or general system problems

   1. Maintenance
   2. Troubleshooting
   3. Service
   4. OEM
   5. Burnout

2. Complete statements about the general procedure for service. Write in the word that best completes each of the following statements.

   a. Gather information about the equipment and type of ______________.

   b. Evaluate equipment ______________.

   c. Investigate ______________ causes of complaints or problems.

   d. Determine the ______________ causes of complaints or problems.

   e. Perform corrective ______________.

3. Solve problems about gathering information about the equipment and type of service. Circle the number in front of the statement that best solves each of the following problems.

   a. On a service call, you have read the work order and talked to the customer, but you still need more information about the appliance. The best source for that information is to:

      1) call the dealer who sold the appliance to the customer.

      2) call the office and get information about a similar system.

      3) get the manufacturer's literature, if it can be located.

Written Test

b. On a service call, you have gathered enough information about the appliance and the problem and are ready to start troubleshooting. However, you should also:

   1) prepare the appliance so you can take it back to the shop.

   2) find out what arrangements the customer has made for payment.

   3) find out if the customer will be home long enough for the repair to be completed.

4. Select true statements about evaluating equipment condition. Place an "X" beside each true statement.

_______ a. A good visual inspection of the appliance will give you little information about how an appliance is really operating, but you should give the appliance a brief visual examination.

_______ b. The most important thing to check is condenser cleanliness because no appliance can operate properly with a dirty condenser and a dirty condenser may cause other components to malfunction.

_______ c. Check for things stacked up and blocking air circulation on, around, or inside the appliance because improper air circulation impairs performance.

_______ d. If the appliance is not already running, start the appliance and observe which components are functioning and how the appliance sounds.

_______ e. Looking and listening means such things as: is light on when door is open? can you hear the evaporator fan? can you hear the compressor? has condensation or ice accumulated in the appliance?

_______ f. If unit operates, operating pressures and temperatures must be obtained, and remember, if the condenser is dirty, it has to be cleaned before taking any pressure or temperature readings.

5. Select true statements about investigating possible causes of problems. Place an "X" beside each true statement.

_______ a. Experienced service technicians often have the cause of a complaint narrowed down to four or five possible causes before they arrive on the service call.

_______ b. For a given complaint, there are usually unlimited possible causes.

_______ c. An experienced service technician can rely on that experience to indicate the possible causes of a problem, but a beginner must use other technicians' experiences which appear in the form of troubleshooting charts.

_______ d. List possible causes of the complaint based on your deductions.

_______ e. Additional observations or research may be necessary to evaluate all the information you have collected.

Written Test

6. Complete statements about determining actual causes of problems. Write in the word that best completes each of the following statements.

   a. A service technician uses the process of ________________ and checks of specific components to determine which of the causes listed during investigation is the actual cause of the problem.

   b. Simple preliminary checks can eliminate many causes:

      1) If any component operates, ________________ voltage is available.

      2) If the compressor cycles when the thermostat setting is changed, the thermostat works and the ________________ motor runs.

      3) The ________________ motor and light can be checked by pushing the switch buttons.

      4) The defrost cycle can be checked by manually turning the defrost ________________ to initiate defrost.

      5) To check motors or heaters, use an ammeter or a ________________ to read current or power usage so it can be compared to manufacturer's specifications.

   c. If any of the components fail to operate, additional checks must be made with a voltmeter and/or the component has to be removed and checked with an ________________.

   d. If all components operate, but the proper temperatures are still not maintained, there may be a problem in the ________________ cycle components.

   e. Operating pressures must be compared with manufacturer's specifications, if available, or a typical ________________ ________________ chart.

   f. Abnormal operating conditions will indicate such problems as undercharge, overcharge, restriction, or compressor ________________ problems.

   g. Abnormal noises, abnormal smells, oil spots, excessive temperature change at some point in a line, or improper frost patterns are good indicators of problem ________________.

   h. Observation of the rate of ________________ of pressures after the compressor stops can be an indication of a restriction or compressor valve problem.

Written Test

i. ________________ make another check until you know what the check you just made means; accumulating information for the sake of accumulating information finds no causes.

7. Select true statements about servicing appliance cabinets. Place an "X" beside each true statement.

_______ a. For a unit to operate properly, the integrity of the interior space must be maintained, meaning that door seals must not leak, catches must latch securely, hinges must be stable, and liners must be sealed.

_______ b. In addition to seals, latches, and liners, other conditions can also affect operation and appearance, conditions such as cabinet out of level, paint chipped, rollers or feet broken, trim loose or missing, shelves or shelf brackets broken, and compartment doors missing or broken.

_______ c. Such things as grease, dirt, and lint detract from a unit's cosmetic appearance and should be cleaned, but they seldom cause any improper operations.

_______ d. Hinges, gaskets, switches, sensors, and many other components will not operate properly with grease or dirt buildup on them.

_______ e. Problems which affect operation seldom have to be corrected before troubleshooting or repair can continue.

_______ f. If a problem will not directly affect operation or continued troubleshooting, the customer should be informed about cost before repair is made.

_______ g. Services generally classified as affecting appearance only should be completed only with customer approval.

_______ h. The customer should be given the opportunity to have services performed that will improve the operating efficiency of the appliance.

8. Solve problems about servicing electrical components. Circle the number in front of the statement that best completes each of the following statements.

   a. You have found a faulty electrical component that can be replaced inexpensively, but you know it's a good idea to check electrical components again even after they check faulty. You should:

      1) Junk the component because the time spent checking it will probably cost more than replacing it, and besides, most faulty electrical components cannot be repaired; they usually have to be replaced.

      2) Save the component until you have time to check it out thoroughly once more.

b. During service you find an electrical component that has complex connections in the system. You know it is going to be difficult to replace the component properly. You should:

   1) Trust the manufacturer's literature to help you reinstall the component properly.

   2) Write down or sketch any information that will help you install a replacement component properly.

9. Complete statements about replacing electrical components. Write in the word that best completes each of the following statements.

   a. When selecting replacement electrical components, consider:

      1) number of electrical ________________ switches have.

      2) position and action of switch ________________ .

      3) motor ________________ .

      4) types of wiring ________________ .

      5) amperage and/or wattage ________________ .

   b. When selecting replacement electrical components, also consider physical properties such as:

      1) physical ________________ .

      2) motor shaft type, ________________, and length.

      3) direction of motor shaft ________________ .

      4) types of mountings and ________________ .

10. Solve problems about servicing refrigeration components. Circle the number in front of the item that best completes each of the following statements.

   a. On a service call, you have just checked operating parameters of a refrigerator-freezer and you have determined that the system needs refrigerant. you know what type and amount of refrigerant to put into the system, but you should also know:

      1) that refrigerant in the system has to be changed first.

      2) that troubleshooting should be completed before you start adding refrigerant.

      3) that a system needing refrigerant probably has a leak that needs to be located.

Written Test

b. You are starting to install a filter drier and know it is the correct size and type of drier, but you should also:

  1) make sure it is full of refrigerant.

  2) make sure the filter-drier is installed horizontally.

  3) make sure the filter-drier is properly oriented in the direction of flow.

11. Complete statements about repairing refrigerant leaks. Write in the word that best completes each of the following statements.

  a. The procedure used to repair leaks depends on such factors as:

    1) the metals involved, aluminum, copper, or ________________ or combinations.

    2) the accessibility of the leak, inside or outside the cabinet, exposed or ________________ , at one end or in the middle of a component.

    3) the location of the appliance, on location or in the shop, out in the open or in a ________________ place.

    4) the ________________ pressures in the part of the system where the leak is found, low pressure or high pressure.

    5) the ________________ cost of a component versus the cost of repairing the component.

  b. Leaks in aluminum tubing can be repaired by brazing or ________________ .

  c. Aluminum-to-aluminum or aluminum-to-copper connections that leak should be removed and either swaged and aluminum soldered back together, or replaced with special ________________ fittings.

  d. Leaks in copper or steel tubing or copper-to-steel connections should be repaired by ________________ .

12. Select true statements about safety while replacing refrigeration components. Place an "X" beside each true statement.

_______ a. If you do not use proper procedures when replacing refrigeration components, you may damage the part you are installing or other parts in the system.

_______ b. Use heat shields or heat-absorbing materials to protect heat-sensitive components or adjacent components when using a torch.

_______ c. Move wiring or other components out of the path of the torch flame or place protective heat shields between the components and the flame.

_______ d. When you use pliers, hammers, or other tools while removing components, work with care to avoid denting, bending, or otherwise damaging components that are going to be reused.

_______ e. When removing refrigeration components, you may have to choose between unsweating a connection or cutting, and you should consider both potential system dangers and replacement costs when deciding which method to use.

_______ f. While unsweating connections preserves original length and shape, it takes a lot of time and adds to customer charges.

_______ g. While cutting minimizes the danger of overheating, the additional fittings or tubing that have to be added are usually expensive.

13. Solve problems about servicing capillary tubes. Circle the number of the item that best completes each of the following statements.

    a. A technician on a service call isolates the capillary tube as a problem in the system. The technician has to decide whether to replace the cap tube or repair it, so the technician should:

        1) definitely replace it because it is too much trouble to clean an old cap tube.

        2) leave the old cap tube in the system, if it can be cleaned, because replacing a cap tube involves the difficult task of connecting a copper cap tube to an aluminum evaporator coil.

    b. A technician removes a cap tube that is soldered to the system suction line. The technician wonders if the new cap tube should also be soldered into place. To be sure, the technician should:

        1) follow the rule that if the original cap tube is soldered to the suction line, the new cap tube should be soldered to the suction line.

        2) follow the rule that a replacement cap tube should be secured in place, but does not, of necessity, have to be soldered in place.

14. Complete statements about replacing compressors. Write in the information that best completes each of the following statements.

    a. After it has been determined that a hermetic compressor has failed either electrically or mechanically, the compressor must be _______________ .

    b. Remember that a compressor has both electrical and mechanical components and considerations for selecting replacement compressors should include:

        1) sizes and locations of _______________ _______________ connections.

        2) _______________ capacity of appliance.

        3) _______________ range of appliance.

        4) type of _______________ ,reciprocal, rotary, etc.

Written Test

5) type and amount of ______________.

6) type of ______________ in system.

7) space available for refrigerant ______________ such as driers and accumulators.

c. Be sure a replacement compressor is either an OEM replacement, or use a cross reference guide to select a compressor that is compatible with system ______________ ______________.

d. A condition known as burnout that often accompanies compressor ______________ failure requires special precautions while removing the burned out compressor and before installinga replacement.

e. Anytime a system has been opened, a new ______________ ______________ ______________ must be installed, and a drier may need to be added to the suction line after a burnout.

f. During a burnout, contaminants may be expelled into components on either side of the ______________, so take special care when you clean a system after a compressor burnout.

Permission to duplicate this test is granted.

Refrigerator and Freezer Service and Repair
Unit 4

Teacher Supplement 1—Using a Troubleshooting Guide

Special Note

The materials in Assignment Sheet 1 introduce students to the importance of troubleshooting guides and how to use them. Because of its importance, the assignment sheet is reproduced here complete with answers. Copy it and give it to students after they have completed the classroom assignment. Students will find the materials a valuable reference as they continue ACR studies and on the job after training is completed.

Permission to reprint this Supplement is granted.

Assignment Sheet 1

Scenario A: The service work order states that a customer complains that food in the refrigerator is getting warm. Upon arrival at the location, you see the light burning when you open the fresh food compartment door, and hear the noise of a fan running inside when you open the freezer compartment door. You turn the temperature control in the fresh food compartment to its coldest setting and you do not hear the compressor start. You pull the appliance out from the wall and find the compressor cool to the touch of your hand.

1. Broken cold control.
2. Broken defrost timer.
3. Wires loose or broken.
4. Broken external overload.
5. Broken compressor (electrical problem).

Scenario B: The service work order states that a customer complains that food in the refrigerator is getting warm. Upon arrival at the location, you see the light burning when you open the fresh food compartment door, and hear the noise of a fan inside when you open the freezer compartment door. You turn the temperature control in the fresh food compartment to its coldest setting and you hear a hum, but you do not hear the compressor running. You pull the appliance out from the wall and find the compressor hot to the touch of your hand.

1. Broken start capacitor.
2. Broken start relay.
3. Broken compressor (electrical problem).
4. Broken compressor (stuck).
5. Restriction in refrigerant line.

Teacher Supplement 1

Scenario C: The service work order states that a customer complains that food is getting warm. Upon arrival at the location, you see the light burning when you open the fresh food compartment door. When you push the fan switch button, you still do not hear a fan running.

1. Broken fan switch.
2. Broken evaporator fan motor.
3. Loose or broken wiring.

Scenario D: The service work order states that a customer complains that food in the refrigerator is getting warm. Upon arrival at the location, you see the light burning when you open the fresh food compartment door, and you hear the fan running when you open the freezer door. You hear the sound of the compressor running coming from underneath he refrigerator, and you can feel warm to hot air blowing out from underneath the refrigerator. You observe that there is no frost buildup in the freezer or around doors.

1. Dirty or obstructed condenser.
2. Insufficient airflow around appliance.
3. Outer shell or inner shell not sealed.
4. Improper use.

Scenario E: The service work order states that a customer complains that food in the refrigerator is getting warm. Upon arrival at the location, you see the light burning when you open the fresh food compartment door and hear the fan running when you open the freezer door. You hear the sound of the compressor running coming from under the refrigerator, and feel warm air blowing out from underneath the appliance. You observe frost and ice buildup in the freezer.

1. Broken defrost timer.
2. Broken defrost heater.
3. Broken defrost heater thermostat.
4. Loose or broken defrost circuit wiring.

Scenario F: The service work order states that a customer complains that food in the refrigerator is getting warm. Upon arrival at the location, you see the light burning when you open the fresh food compartment door and hear the fan running when you open the freezer door. You hear the sound of the compressor running coming from underneath the refrigerator, and feel cool or room temperature air blowing out from underneath the appliance.

1. Shortage of refrigerant.
2. Compressor valves not holding.

Teacher Supplement 1

Scenario G: The service work order states that a customer complains that food in the freezer is thawing out even though food in the fresh food compartment seems fine. Upon arrival at the location, you see the light burning when you open the fresh food compartment door and hear the fan running when you open the freezer door. The freezer compartment is packed so full you cannot get to the control in the freezer compartment.

1. Improper use.
2. Controls not set properly.
3. Broken airflow control.
4. Broken airflow heater.

Scenario H: The service work order states that a customer complains that milk is spoiling too quickly even though food in the freezer stays frozen fine. Upon arrival at the location, you see the light burning when you open the fresh food compartment, and hear the fan running when you open the freezer door. You hear the compressor start when you turn the cold control to a colder setting, and the temperature begins to drop. You can feel air blowing in the fresh food compartment when you push the fan switch button.

1. Improper use.
2. Poor door seal.
3. Controls not set properly.
4. Light switch stuck closed.
5. Outer or inner shell not sealed.

Scenario I: The service work order states that a customer complains that milk is spoiling too quickly even though food in the freezer stays frozen fine. Upon arrival at the location, you find the light burning when you open the fresh food compartment, and hear the fan running when you open the freezer door. You hear the compressor start when you turn the cold control to a colder setting, and the temperature begins to drop. You feel little or no air blowing in the fresh food compartment when you push the fan switch button, even though you hear the fan running.

1. Airflow control not set properly.
2. Broken airflow control.
3. Air not able to get through air duct.

Teacher Supplement 1

Scenario J: The service work order states that a customer complains that even though there have been no problems with fresh food temperatures, ice cream gets too hard and the refrigerator runs all the time. Upon arrival at the location, the compressor continues to run when you turn the cold control to its warmest setting.

1. Broken cold control.
2. Improperly positioned control sensor.

Scenario K: The service work order states that a customer complains that even thought here have been no problems with fresh food temperatures, ice cream gets too hard and the refrigerator runs all the time. Upon arrival at the location, the compressor stops when you turn the cold control to a warmer setting.

1. Controls not set properly.
2. Improperly positioned control sensor.

Scenario L: The service work order states that a customer complains that everything in all compartments gets too cold. Upon arrival at the location, you find that everything seems to be functioning, but the compressor continues to run when you turn the control to its warmest setting.

1. Broken cold control.
2. Improperly positioned control sensor.

Scenario M: The service work order states that a customer complains that even though fresh and frozen foods seem to keep, the refrigerator seems to run all the time, and the customer is worried about getting a high electric bill. Upon arrival at the location, you see the light come on when you open the fresh food compartment door and go off when you push the light switch button. There appears to be no problems with airflow blockage around or above the refrigerator. Conditions in the kitchen where the refrigerator is located seem to be about average.

1. Poor seals.
2. Improper use.
3. Improperly positioned control sensor.
4. Improper refrigerant charge.

Scenario N: The service work order states that a customer complains that both fresh and frozen foods seem to be getting too warm. Upon arrival at the location, you hear the noise of the compressor starting and stopping every few minutes. You pull the refrigerator out from the wall and find the compressor cool to the touch.

1. Weak overload.

Teacher Supplement 1

Scenario O: The service work order states that a customer complains that there is a funny noise coming out of the refrigerator. Upon arrival at the location, you observe that the appliance appears to be level and the floor underneath seems to be stable. You observe that the appliance does not have an ice maker. You remove the condensate pan and observe that the pan is clean and in place.

1. Refrigerant tubing vibrating against other components.
2. Loose components in contact with fan blade.

Refrigerator and Freezer Service and Repair
Unit 4

Unit Evaluation Form

Student Name ______________________________ Unit Rating ____________

Assignment Sheet 1—Use a Troubleshooting Guide to Find Possible Causes of Customer Complaints Rating ______

Comments:

Assignment Sheet 2—Diagnose Circuit Problems Using a Schematic Rating ______

Comments:

Assignment Sheet 3—Select Filter-Driers for Given Applications Rating ______

Comments:

Assignment Sheet 4—Select Compressors for Given Applications Rating ______

Comments:

Job Sheet 1—Perform Maintenance on a Refrigerator or Freezer Rating ______

Comments:

Job Sheet 2—Remove and Replace Breaker Trim Rating ______

Comments:

Job Sheet 3—Troubleshoot Selected Problems With a Refrigerator or Freezer Rating ______

Comments:

Job Sheet 4—Check the Efficiency of a Compressor Rating ______

Comments:

Unit Evaluation Form

Job Sheet 5—Replace an Evaporator Fan Motor Rating ______

Comments:

Job Sheet 6—Replace a Condenser Fan Motor Rating ______

Comments:

Job Sheet 7—Install a Process Tube Adapter on a Refrigerator or Freezer Rating ______

Comments:

Job Sheet 8—Repair a Leak in an Aluminum Evaporator Using Paste Epoxy Rating ______

Comments:

Job Sheet 9—Repair a Leak in an Aluminum Evaporator Using a Pre-Mixed, Two-Part Epoxy Stick Rating ______

Comments:

Job Sheet 10—Repair a Hole in an Aluminum Evaporator by Brazing Rating ______

Comments:

Job Sheet 11—Make an Aluminum-to-Aluminum or an Aluminum-to-Copper Swage Joint Rating ______

Comments:

Job Sheet 12—Replace a Liquid-Line Filter Drier Rating ______

Comments:

Job Sheet 13—Charge a Small, Refrigerated Appliance Using a Charging Cylinder Rating ______

Comments:

Unit Evaluation Form

Job Sheet 14—Charge a Small, Refrigerated Appliance Using Charging Scales Rating ______

Comments:

Job Sheet 15—Service a Capillary Tube Rating ______

Comments:

Job Sheet 16—Replace a Compressor Rating ______

Comments:

Other:

Written Tests: __________ Pretest __________ Posttest __________

Total __________

Teacher Signature ______________________________ Date __________

Student Signature ______________________________ Date __________

Permission to duplicate this form is granted.

Refrigerator and Freezer Service and Repair
Unit 4

Information Sheet

1. **Terms and definitions**

   a. **Burnout**—A total compressor failure usually resulting in overheating to such a degree that it poses a contamination problem to the entire system

   b. **Maintenance**—Procedures performed at scheduled intervals to check and service critical components or conditions of a refrigerated appliance in order to minimize the need for repairs and maximize system performance

   c. **OEM (Original Equipment Manufacturer)**—The company that manufactures the original appliance

   d. **Service**—Performing maintenance, troubleshooting, and/or repairs

   e. **Troubleshooting**—A systematic approach to determine the cause(s) of component malfunctions or general system problems

2. **General procedure for service**

   a. Gather information about the equipment and type of service.

   b. Evaluate equipment condition.

   c. Investigate possible causes of complaints or problems.

   d. Determine the actual causes of complaints or problems.

   e. Perform corrective service.

3. **Gathering information about the equipment and type of service**

   a. A service technician's best resource is the past history of the appliance; this history can be obtained from service records, if available, or from the customer's records or verbal report of unit history.

   b. Information needed includes:

      1) name of the manufacturer.

      2) model and serial numbers.

      3) age of the appliance.

      4) major repairs which have been made.

      5) how customer has maintained appliance.

      6) what arrangements have been made for payment.

      7) temperature range of the appliance.

Information Sheet

Operating Conditions	General Product Types	Approximate Evaporator Temperature
(a) Low temperature and low pressure	Frozen or fresh and frozen foods	–30°F and up
(b) Medium temperature and medium pressure	Fresh food only	+10°F and up
(c) High temperature and high pressure	Beverages, salads, drinking water, etc.	+20°F and up

c. The unit data plate contains much of the above information as well as other helpful information.

d. Obtain from the customer as much information as you can about how the unit has been performing recently.

e. Information from the customer may be obtained from the initial company work order or from the customer, if present at time of service.

f. If manufacturer's literature can be located, it is the best source for information about the appliance.

g. The service technician's training, experience, and knowledge can also be a good source of information about the appliance and the customer.

4. Evaluating equipment condition

a. A good visual inspection of the appliance will give you a great deal of information about how the appliance is operating.

b. The most important thing to check is condenser cleanliness because no appliance can operate properly with a dirty condenser and a dirty condenser may cause other components to malfunction.

c. Check for things stacked up and blocking air circulation on, around, or inside the appliance because improper air circulation impairs performance.

d. If the appliance is not already running, start the appliance and observe which components are functioning and how the appliance sounds.

e. Looking and listening means such things as: is light on when door is open? can you hear the evaporator fan? can you hear the compressor? has condensation or ice accumulated in the appliance?

f. If unit operates, operating pressures and temperatures must be obtained, and remember, if the condenser is dirty, it has to be cleaned before taking any pressure or temperature readings.

Note: As you make your pressure/temperature readings be sure to record them so you can put them on the service work order.

Information Sheet

5. Investigating possible causes of problems

a. Experienced service technicians often have the cause of a complaint narrowed down to two or three, or sometimes only one, possible cause(s) before they arrive on the service call.

b. For a given complaint, there are a limited number of possible causes.

c. An experienced service technician can rely on that experience to indicate the possible causes of a problem, but a beginner must use other technician's experiences which appear in the form of troubleshooting charts.

Note: See the troubleshooting chart in Student Supplement 1.

d. List possible causes of the complaint based on your deductions.

e. Additional observations or research may be necessary to evaluate all the information you have collected.

Note: Research may mean reading manufacturer's literature or other reference material, or talking to a supervisor or another technician who is more experienced.

6. Determining actual causes of problems

a. A service technician uses the process of elimination and checks of specific components to determine which cause(s) listed during investigation is the actual cause(s) of the problem.

Note: Typical causes and procedures are presented in Student Supplement 1.

b. Simple preliminary checks can eliminate many causes:

1) If any component operates, source voltage is available.

2) If the compressor cycles when the thermostat setting is changed, the thermostat works and the compressor motor runs.

3) The evaporator fan motor and light can be checked by pushing the switch buttons.

4) The defrost cycle can be checked by manually turning the defrost timer to initiate defrost.

5) To check motors or heaters, use an ammeter or a wattmeter to read current or power usage so it can be compared to manufacturer's specifications.

c. If any of the components fail to operate, additional checks must be made with a voltmeter and/or the component has to be removed and checked with an ohmmeter.

d. If all components operate, but the proper temperatures are still not maintained, there may be a problem in the refrigeration cycle components.

Information Sheet

e. Operating pressures must be compared with manufacturer's specifications, if available, or a typical operating conditions chart.

Note: Always attempt to locate manufacturer's specifications; use a typical operating conditions chart only as a last resort.

f. Abnormal operating conditions will indicate such problems as undercharge, overcharge, restriction, or compressor valve problems.

g. Abnormal noises, abnormal smells, oil spots, excessive temperature change at some point in a line, or improper frost patterns are good indicators of problem locations.

h. Observation of the rate of equalization of pressures after the compressor stops can be an indication of a restriction or compressor valve problem.

i. Never make another check until you know what the check you just made means; accumulating information for the sake of accumulating information finds no causes.

7. Servicing appliance cabinets

a. For a unit to operate properly, the integrity of the interior space must be maintained, meaning that door seals must not leak, catches must latch securely, hinges must be stable, and liners must be sealed.

b. In addition to seals, latches, and liners, other conditions can also affect operation and appearance, conditions such as cabinet out off level, paint chipped, rollers or feet broken, trim loose or missing, shelves or shelf brackets broken, and compartment doors missing or broken.

c. Such things as grease, dirt, and lint not only detract from a unit's cosmetic appearance, but can cause improper operation as well.

d. Hinges, gaskets, switches, sensors, and many other components will not operate properly with grease or dirt buildup on them.

Note: Reference the troubleshooting chart in Student Supplement 1 to see how cabinet conditions can affect operation; be sure to note items in 3a, 3b, 3f, and 3g.

e. Problems which affect operation may have to be corrected before troubleshooting or repair can continue.

f. If a problem will not directly affect operation or continued troubleshooting, the customer should be informed about cost before repair is made.

g. Services generally classified as affecting appearance only should be completed only with customer approval.

h. The customer should be given the opportunity to have services performed that will improve the operating efficiency of the appliance.

Note: Customers usually appreciate knowing that problems need to be corrected; additional service or the opportunity to sell a new appliance adds to company profits and, sometimes, a commission.

Information Sheet

8. Servicing electrical components

a. If preliminary observations indicate that some electrical component is not functioning or not functioning properly, check the component or circuit as required to determine the specific cause of the problem.

b. If a check of a component indicates the component is faulty, repair or replace the component, and you will probably have to replace it because electrical components usually cannot be repaired.

c. Observe closely how the part to be removed is installed in the unit, and write down or sketch anything that might be useful during replacement.

d. Be sure to check electrical components again after you have removed them to be certain that you have not misdiagnosed the problem.

e. Sometimes the only required service is to clean the component thoroughly, recheck it, and reinstall it.

f. Check carefully the specifications and/or part numbers of parts you remove, on the part itself or in manufacturer's literature, to be certain you select the proper replacement.

9. Replacing electrical components

a. When selecting replacement electrical components, consider electrical parameters such as:

   1) number of electrical poles switches have.

   2) position and action of switch contacts.

   3) motor horsepower.

   4) types of wiring connections.

   5) amperage and/or wattage ratings.

b. When selecting replacement electrical components, also consider physical properties such as:

   1) physical dimensions.

   2) motor shaft type, diameter, and length.

   3) direction of motor shaft rotation.

   4) types of mountings and fasteners.

Note: Use OEM replacement when available.

10. Servicing refrigeration components

a. If operating parameters indicate that a component is not operating properly, the component almost always has to be replaced.

Information Sheet

b. Remember, the refrigerant from any appliance must be removed according to EPA regulations before dismantling the refrigeration system.

c. Observe closely how components are installed in the system and note anything that would be helpful during replacement.

d. Check carefully the specifications and/or part numbers of parts removed, on the part itself or in manufacturer's literature so that you can select the proper replacement.

e. Be sure to check direction of flow through refrigeration components to assure that directionally-oriented components are properly installed.

f. If operating parameters indicate that the system needs refrigerant, it can be assumed that the system leaks.

Note: When charging a system, always weigh in a full charge; partial charges are not accurate and should be used only until repairs are completed.

g. A system should be checked for leaks anytime a leak is suspected or anytime refrigeration components are added or replaced.

h. Anytime oil is lost or removed from a refrigeration system, the same amount and type of refrigerant oil must be added to the system.

Note: New compressors may come with an oil charge or come with specifications for the amount and type of acceptable alternative oils.

11. Repairing refrigerant leaks

a. The procedure used to repair leaks depends on such factors as:

   1) the metals involved, aluminum, copper, or steel or combinations.

   2) the accessibility of the leak, inside or outside the cabinet, exposed or hidden, at one end or in the middle of a component.

   3) the location of the appliance, on location or in the shop, out in the open or in a tight place.

   4) the operating pressures in the part of the system where the leak is found, low pressure or high pressure.

   5) the replacement cost of a component versus the cost of repairing the component.

b. Leaks in aluminum tubing can be repaired by brazing or epoxy.

c. Aluminum-to-aluminum or aluminum-to-copper connections that leak should be removed and either swaged and aluminum soldered back together, or replaced with special mechanical fittings.

d. Leaks in copper or steel tubing or copper-to-steel connections should be repaired by brazing.

Information Sheet

12. Safety while replacing refrigeration components

a. Use proper procedures when replacing refrigeration components, or you may damage the part you are installing or other parts in the system.

b. Use heat shields or heat-absorbing materials to protect heat-sensitive components or adjacent components when using a torch.

c. Move wiring or other components out of the path of the torch flame or place protective heat shields between the components and the flame.

d. When you use pliers, hammers, or other tools while removing components, work with care to avoid denting, bending, or otherwise damaging components that are going to be reused.

e. When removing refrigeration components, you may have to choose between unsweating a connection or cutting.

f. While unsweating connections preserves original length and shape, it presents the danger of overheating.

g. While cutting minimizes the danger of overheating, additional fittings or tubing may have to be added to get a new component to fit.

13. Servicing capillary tubes

a. Since cap tubes function in a fairly narrow range of operating conditions, care must be taken in considering the many parameters that may affect cap tube operation.

b. Parameters that affect cap tube operation include:

    1) length.

    2) inside diameter.

    3) capacity of compressor motor.

    4) temperature range of the system.

    5) type of refrigerant.

    6) type of evaporator.

    7) type of condenser.

c. Cap tube repair is often preferred over replacement because connecting a copper cap tube to an aluminum evaporator coil can be very difficult.

d. Cap tubes can be cleaned with any one of a variety of cap tube cleaners on the market; in all cases follow the cleaner manufacturer's directions.

Information Sheet

e. If the original cap tube is soldered to the suction line, which most cap tubes are, the replacement must also be soldered to the suction line.

f. If a cap tube is damaged or restricted near the end which is connected to the liquid line, you can sometimes replace a section of the cap tube.

14. Replacing compressors

a. After it has been determined that a hermetic compressor has failed either electrically or mechanically, the compressor must be replaced.

Note: Many compressors returned to manufacturers have nothing wrong with them; be sure to double check a compressor before you remove and return it!

b. Remember that a compressor has both electrical and mechanical components and mechanical considerations for selecting replacement compressors should include:

1) sizes and locations of refrigerant line connections.

2) Btuh capacity of appliance.

3) temperature range of appliance.

4) type of compressor, reciprocal, rotary, etc.

5) type and amount of refrigerant.

6) type of oil in system.

7) space available for refrigerant accessories such as driers and accumulators.

c. Be sure a replacement compressor is either an OEM replacement, or use a cross reference guide to select a compressor that is compatible with system operating parameters.

Note: See Assignment Sheet 4.

d. A condition known as burnout that often accompanies compressor electrical failure requires special precautions while removing the burned out compressor and before installing a replacement.

Note: See Job Sheet 16.

e. Anytime a system has been opened, a new liquid line drier must be installed, and a drier may need to be added in the suction line after a burnout.

f. During a burnout, contaminants may be expelled into components on either side of the compressor, so take special care when you clean a system after a compressor burnout.

Refrigerator and Freezer Service and Repair
Unit 4

Student Supplement 1—Refrigerator and Freezer Troubleshooting Guide

Symptom and Possible Causes	Troubleshooting Procedure
1. Fresh food and freezer compartments are too warm; nothing runs	
a. No source voltage or low voltage	Check source voltage (none) Replace fuse or reset breaker Check source voltage (none or more than 10% below rating Ask user to call electrician
b. Broken cord	Check source voltage (present) Check voltage where cord connects to unit (none) Replace cord
2. Fresh food and freezer compartments too warm; compressor not running; light burns or fan runs	
a. Cold control not set properly	Turn cold control to colder setting (compressor runs and temperature drops after a few minutes of operation) Inform user and suggest checking operating instructions for proper control settings Set control(s) for desired temperatures, and volunteer to show user
b. Broken cold control	Turn cold control to colder setting (compressor does not run) Jumper across terminals (compressor runs and temperature drops after a few minutes of operation) Replace control
c. Broken defrost timer	See 2b (compressor does not run after terminals jumped) Manually rotate defrost timer (compressor starts) Remove timer, hook up test cord and check operation (timer motor fails to run or contacts do not close) Replace timer
d. Wires loose or broken	See 2c (compressor does not run after timer rotated) Check connections at controls and at compressor (loose or broken) Repair or replace wires
e. Broken start capacitor	See 2d (wiring okay when checked) Check capacitor appearance (may be discolored, oily, or cracked) Remove capacitor and check with ohmmeter or capacitor analyzer (open, shorted, or weak) Replace start capacitor
f. Broken start relay	See 2e (capacitor checks okay) Remove relay and check with ohmmeter or component analyzer (open coil or open or stuck contacts) Replace start relay

Student Supplement 1

Symptoms and Possible Causes	Troubleshooting Procedures
2. (cont.)	
g. Broken external overload	See 2f (relay checks okay) Check voltage at common and line on start relay (source voltage available) Remove overload and check with ohmmeter (open) (**Caution:** verify overload is not overheated) Replace overload
h. Broken compressor (electrical problem)	See 2g (overload checks okay) Feel compressor (not hot or warm to touch) Isolate terminals from system wiring and check compressor motor (open, shorted, or grounded) (**Caution:** verify that internal overload, if it has one, has had sufficient time to cool; this may take several hours) Replace compressor
i. Restriction in refrigerant line	Feel compressor (warm or hot to touch) See 2h (Compressor motor does not check open, shorted, or grounded) Hook compressor motor to test cord or hemetic analyzer and compare amperage to locked rotor rating (above rating) Install suction valve, ir not provided, and check suction pressure (much too low) Install discharge valve, if not provided, and check discharge pressure (much too high) Recover refrigerant and attempt to start the compressor (compressor starts) Locate restriction, repair, replace liquid line drier, evacuate, and recharge with refrigerant
j. Broken compressor (stuck)	See 2i (no restriction found) Use a test cord or hermetic analyzer to momentarily apply a larger than normal start capacitor to attempt to start the motor (motor fails to start) Use a test cord or hermetic analyzer to momentarily reverse the motor and attempt to start again (fails to start) Use a test cord to apply higher than normal voltage (fails to start) Replace compressor
3. Fresh food and freezer compartments too warm; compressor runs	
a. Dirty or obstructed condenser	Check condenser for proper air flow (dirty or obstructed) Clean condenser or remove obstructions
b. Insufficient airflow around appliance	Check appliance installation for proper clearances Check for items blocking airflow Reposition appliance, remove blockage, or inform user
c. Broken fan switch	Push fan switch button (fan does not run) Jumper switch (fan runs) Replace fan switch

Student Supplement 1

Symptoms and Possible Causes	Troubleshooting Procedures
3. (cont.)	
d. Broken evaporator fan motor	See 3c (fan fails to run when switch jumped) Check voltage at motor terminals (proper voltage) Remove fan motor and check (open, shorted, grounded, or bearings worn out) Replace motor
e. Loose or broken wiring in evaporator fan circuit	See 3d (no voltage at motor terminals) Check wires and connections to evaporator fan motor (loose or broken) Repair or replace wiring
f. Poor door seal	Check for ice buildup around door(s) (ice or moisture present) Check appliance w/level (not level) Level appliance (appliance level when checked) Check door gasket(s) (cracked, brittle, worn, or door out of adjustment) Adjust door and/or replace gasket(s)
g. Outer shell or inner shell not sealed	Check for ice buildup in insulation or between shells; remove trim as necessary Melt ice and dry insulation or replace Seal shell leaks and joints and reassemble
h. Broken mullion heater	See 3f (door and gasket check okay) Disconnect heater and check for continuity (no continuity) Connect alternate heater, if available, or replace heater
i. Broken defrost timer	Check finned evaporator (blocked w/ice) Check defrost timer (not running) Remove timer and connect it to a test cord (motor will not run) Replace timer (Motor runs when timer checked) Check timer contacts (contacts open when they should be closed) Replace timer
j. Broken defrost heater	See 3i (defrost timer running) Check voltage to heater (voltage present) Check for amperage draw (none found) Replace heater
k. Broken defrost heater thermostat	See 3j (voltage to defrost heater not present) Check voltage at common end of heater and power side of thermostat (voltage present) Remove thermostat and check resistance (no resistance) Replace defrost heater thermostat
l. Loose or broken wiring in defrost circuit	See 3k (voltage not present at thermostat) Check wiring and connections (wiring loose or broken) Repair or replace wiring

Student Supplement 1

Symptoms and Possible Causes	Troubleshooting Procedures
3. (cont.)	
m. Shortage of refrigerant	Check fans and lights (all working) Install suction access valve, if not provided, and check pressure (pressure too low) Check for leak, repair, evacuate, and recharge with refrigerant
n. Compressor valves not holding	See 3m (pressure too high) Check compressor running amperage (too low) Install access valve as needed; check high side pressure (too low) Replace compressor
o. Improper use	Tactfully question user about patterns of use (patterns such as repeated door openings, overloading of shelves, or blocking normal air circulation in cabinet) Inform user of better use patterns
4. Fresh food compartment too warm, freezer compartment normal	
a. Improper use	See 3o
b. Poor door seal	See 3f
c. Cold control not set properly	See 2a
d. Airflow control not set properly	Turn control to colder setting (temperature lowers after a few minutes of operation) Check operating instructions for proper settings of both air flow control and cold control Set controls for desired temperatures, and volunteer to show user how
e. Broken airflow control	Turn control to colder setting (temperature does not lower after a few minutes of operation) Remove airflow control and inspect for damage (damage found) Repair or replace airflow control
f. Air not able to get thru duct	Feel if air blowing through or test with strip of tissue paper Check opening for blockage or grille or duct being out of position or not properly sealed (problem found) Reposition or reseal as needed
g. Light switch stuck closed	Push light switch button (light stays on) Replace switch
h. Outer or inner shell not sealed	See 3g

Student Supplement 1

Symptoms and Possible Causes	Troubleshooting Procedures
5. Fresh food compartment too cold; freezer normal	
a. Improper use	See 3o
b. Airflow control not set properly	Turn control to warmer position (compartment temperature rises after a few minutes) See 4d
c. Broken airflow control	Turn control to warmer position (compartment temperature does not rise after a few minutes) See 4e
d. Broken airflow heater	See 4e (no damage found) Check voltage to heater (voltage present) Check amperage draw (none found) Replace heater
6. Freezer compartment too cold; fresh food compartment normal compressor runs all the time	
a. Controls not set properly	Turn cold control to warmest position (compressor stops running and temperature rises after a few minutes) See 2a
b. Broken cold control and airflow control not set properly	See 6a (compressor does not stop) Disconnect wires from cold control and check for continuity of contacts (contacts closed) Remove cold control Warm control sensor or bulb to above 45°F and check continuity again (contacts closed) Replace control Reset all controls to desired settings
c. Improperly positioned control sensor and airflow control not set properly	See 6b (contacts open when sensor warmed) Reinstall control and position sensor properly Set controls to desired settings
7. All compartments too cold; compressor runs all the time	
a. Cold control not set properly	See 6a
b. Broken cold control	See 6b
c. Improperly positioned control sensor	See 6c
8. Temperatures normal; compressor runs all the time	
a. Insufficient airflow around appliance	See 3b

Student Supplement 1

Symptom and Possible Causes	Troubleshooting Procedure
8. (cont.)	
b. Room temperature too warm	Inform user
c. Poor seal(s)	See 3f
d. Improper use	See 3o
e. Light switch stuck closed	See 4g
f. Control sensor improperly positioned	See 6c
g. Improper refrigerant charge	Check compressor amps (amps too high or too low) Install suction valve, if not provided, and check pressure (pressure too high or too low) Install liquid valve, if not provided, and check pressure (pressure too high or too low at same time as suction pressure) Recover refrigerant, evacuate, and recharge with proper amount and type of refrigerant
9. Temperatures too warm; compressor starts and stops	
a. Weak external or internal overload	Check compressor shell temperature by touching with your hand or use a thermometer (not excessive) Check compressor running amperage (normal) Check voltage at common terminal and line on start relay (source voltage available) Replace external overload or replace compressor if overload is internal
b. Moisture in refrigerant	See 9a (shell temperature excessive) Install access valves as needed Check pressures when compressor first starts, while compressor is running, and observe pressure changes after compressor stops (pressures normal at first, gradually changing to symptoms of a restriction, see 2i) Recover refrigerant, install new drier, evacuate, and recharge
c. Too much refrigerant	Feel compressor (hot to touch) See 8g (amps and both pressures too high) Proceed as in 8g
d. Restriction in refrigerant line	See 2i (suction pressure low and discharge pressure high when compressor running; pressures equalize very slowly or not at all when compressor stops) Proceed as in 2i

Student Supplement 1

Symptoms and Possible Causes	Troubleshooting Procedures
10. Noisy operation	Listen to locate approximate location of noise
a. Appliance not level	Check with level and level as necessary
b. Adjacent flooring or cabinets loose	Pull appliance out from wall and check installation (loose flooring or cabinets) Make minor repairs or inform user
c. Condensate pan improperly positioned	Check pan and reposition
d. Water line to appliance not secure	Pull appliance out from wall and check installation of water line; secure as needed
e. Refrigerant tubing vibrating against other tubing or components	Check tubing and reposition or secure as needed
f. Loose components in contact with fan blade	Check for loose components; repair as needed

Refrigerator and Freezer Service and Repair
Unit 4

Assignment Sheet 1—Use a Troubleshooting Guide to Find Possible Causes of Customer Complaints

Name ______________________________ Overall Rating ______________

Evaluation Criteria	**Rating**
Number of causes listed	______
Number of correct causes listed	______

Directions: Read the following service scenarios carefully and after consulting the troubleshooting guide in Student Supplement 1, list possible causes of the customer complaints or describe what the service technician should do.

Example scenario:

> The service work order states that a customer complains that the food in the refrigerator is getting warm and the appliance makes no noise at all. Upon arrival at the location, you see no light burning and you hear no noise when you open either compartment door.

Procedure: Go to the troubleshooting guide and find the symptom that matches the customer complaint. In this example, the symptom is item 1, fresh food and freezer compartments are too warm; nothing runs. Below the symptom is a list of possible causes. Use the checks that you make to identify which of the listed causes are possible causes of the problem in the appliance. In this example, neither of the listed causes can be eliminated by your checks, so list both causes.

1. No source voltage or low voltage (blown fuse or tripped breaker would also be acceptable).
2. Broken cord.

Follow up: Once you have listed possible causes, follow the steps in the troubleshooting procedure column to identify the specific cause of the problem. Information in parentheses shows what results you will get from a check if the listed cause is the problem. Any result other than that shown in parentheses means that the cause listed is not the real cause of the problem. This process of elimination is what troubleshooting is all about.

Scenario A: The service work order states that a customer complains that food in the refrigerator is getting warm. Upon arrival at the location, you see the light burning when you open the fresh food compartment door, and hear the noise of a fan running inside when you open the freezer compartment door. You turn the temperature control in the fresh food compartment to its coldest setting and you do not hear the compressor start. You pull the appliance out from the wall and find the compressor cool to the touch of your hand.

1. ____

2. ____

Assignment Sheet 1

3. ______________________________

4. ______________________________

5. ______________________________

Scenario B: The service work order states that a customer complains that food in the refrigerator is getting warm. Upon arrival at the location, you see the light burning when you open the fresh food compartment door, and hear the noise of a fan inside when you open the freezer compartment door. You turn the temperature control in the fresh food compartment to its coldest setting and you hear a hum, but you do not hear the compressure running. You pull the appliance out from the wall and find the compressor hot to the touch of your hand.

1. ______________________________

2. ______________________________

3. ______________________________

4. ______________________________

5. ______________________________

Scenario C: The service work order states that a customer complains that food is getting warm. Upon arrival at the location, you see the light burning when you open the fresh food compartment door. When you push the fan switch button, you still do not hear a fan running.

1. ______________________________

2. ______________________________

3. ______________________________

Scenario D: The service work order states that a customer complains that food in the refrigerator is getting warm. Upon arrival at the location, you see the light burning when you open the fresh food compartment door, and you hear the fan running when you open the freezer door. You hear the sound of the compressor running coming from underneath he refrigerator, and you can feel warm air blowing out from underneath the refrigerator. You observe that there is no frost buildup in the freezer or around doors.

1. ______________________________

2. ______________________________

3. ______________________________

4. ______________________________

Assignment Sheet 1

Scenario E: The service work order states that a customer complains that food in the refrigerator is getting warm. Upon arrival at the location, you see the light burning when you open the fresh food compartment door and hear the fan running when you open the freezer door. You hear the sound of the compressor running coming from under the refrigerator, and feel warm air blowing out from underneath the appliance. You observe frost and ice buildup in the freezer.

1. ____
2. ____
3. ____
4. ____

Scenario F: The service work order states that a customer complains that food in the refrigerator is getting warm. Upon arrival at the location, you see the light burning when you open the fresh food compartment door and hear the fan running when you open the freezer door. You hear the sound of the compressor running coming from underneath the refrigerator, and feel cool or room temperature air blowing out from underneath the appliance.

1. ____
2. ____

Scenario G: The service work order states that a customer complains that food in the freezer is thawing out even though food in the fresh food compartment seems fine. Upon arrival at the location, you see the light burning when you open the fresh food compartment door and hear the fan running when you open the freezer door. The freezer compartment is packed so full you cannot get to the control in the freezer compartment.

1. ____
2. ____
3. ____
4. ____

Scenario H: The service work order states that a customer complains that milk is spoiling too quickly even though food in the freezer stays frozen fine. Upon arrival at the location, you see the light burning when you open the fresh food compartment, and hear the fan running when you open the freezer door. You hear the compressor start when you turn the cold control to a colder setting, and the temperature begins to drop. You can feel air blowing in the fresh food compartment when you push the fan switch button.

1. ____
2. ____
3. ____

Assignment Sheet 1

4. ______________________________

5. ______________________________

Scenario I: The service work order states that a customer complains that milk is spoiling too quickly even though food in the freezer stays frozen fine. Upon arrival at the location, you see the light burning when you open the fresh food compartment, and hear the fan running when you open the freezer door. You hear the compressor start when you turn the cold control to a colder setting, and the temperature begins to drop. You feel little or no air blowing in the fresh food compartment when you push the fan switch button, even though you hear the fan running.

1. ______________________________

2. ______________________________

3. ______________________________

Scenario J: The service work order states that a customer complains that even though there have been no problems with fresh food temperatures, ice cream gets too hard and the refrigerator runs all the time. Upon arrival at the location, the compressor continues to run when you turn the cold control to its warmest setting.

1. ______________________________

2. ______________________________

Scenario K: The service work order states that a customer complains that even thought here have been no problems with fresh food temperatures, ice cream gets too hard and the refrigerator runs all the time. Upon arrival at the location, the compressor stops when you turn the cold control to a warmer setting.

1. ______________________________

2. ______________________________

Scenario L: The service work order states that a customer complains that everything in all compartments gets too cold. Upon arrival at the location, you find that everything seems to be functioning, but the compressor continues to run when you turn the control to its warmest setting.

1. ______________________________

2. ______________________________

Assignment Sheet 1

Scenario M: The service work order states that a customer complains that even though fresh and frozen foods seem to keep, the refrigerator seems to run all the time, and the customer is worried about getting a high electric bill. Upon arrival at the location, you see the light come on when you open the fresh food compartment door and go off when you push the light switch button. There appear to be no problems with airflow blockage around or above the refrigerator. Conditions in the kitchen where the refrigerator is located seem to be about average.

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________

Scenario N: The service work order states that a customer complains that both fresh and frozen foods seem to be getting too warm. Upon arrival at the location, you hear the noise of the compressor starting and stopping every few minutes. You pull the refrigerator out from the wall and find the compressor cool to the touch.

1. ______________________________

Scenario O: The service work order states that a customer complains that there is a funny noise coming out of the refrigerator. Upon arrival at the location, you observe that the appliance appears to be level and the floor underneath seems to be stable. You observe that the appliance does not have an ice maker. You remove the condensate pan and observe that the pan is clean and in place.

1. ______________________________
2. ______________________________

Refrigerator and Freezer Service and Repair
Unit 4

Assignment Sheet 2—Diagnose Circuit Problems Using a Schematic

Name ______________________________ Overall Rating ____________

Evaluation Criteria	Rating
Number of correct answers, Part I	_____
Number of correct answers, Part II	_____
Total number of correct answers	_____

Part I

Directions: Examine the ladder schematic that accompanies this assignment sheet and carefully read the stated conditions of electrical test instruments. Checks are sequential: each check assumes all necessary previous checks have been made. The ladder schematic is on a separate page so you can put it alongside the condition statements as you write your answers. Indicate why the check should be made and what the meter reading indicates.

Service Conditions

On a refrigerator you are checking, the compressor motor is not running, and the evaporator fan motor and compartment light do not come on when you push the switch buttons.

Example: **Test meter conditions:** Voltmeter probes at H and N.
Why make this check?
Answer: To determine if source voltage is available to the refrigerator.
What does a voltage reading of 120 VAC indicate?
Answer: Source voltage is available.

1. **Test meter conditions:** Voltmeter probes at A and D.

   Why make this check?

   ____

   ____

   What does a meter reading of 120 VAC indicate?

   ____

   ____

Assignment Sheet 2

2. **Test meter conditions:** Ohmmeter probes at A and B with one side disconnected to prevent getting a reading through some other circuit.

   Why make this check?

   ____

   ____

   What does a meter reading of ∞ indicate?

   ____

   ____

3. **Test meter conditions:** Voltmeter probes at F and G.

   Why make this check?

   ____

   ____

   What does a meter reading of 120 VAC indicate?

   ____

   ____

4. **Test meter conditions:** Voltmeter probes at 1 and 2 on the defrost timer.

   Why make this check?

   ____

   ____

   What does a meter reading of 120 VAC indicate?

   ____

   ____

5. **Test meter conditions:** Voltmeter probes at 2 on the defrost timer and at J.

   Why make this check?

   ____

   ____

Assignment Sheet 2

What does a meter reading of 120 VAC indicate?

6. **Test meter conditions:** Voltmeter probes at I and at J.

   Why make this check?

   What does a meter reading of 0 VAC indicate?

7. **Test meter conditions:** Clamp-on ammeter on wire between 2 and K.

   Why make this check?

   What does a meter reading that shows current draw indicate?

8. **Test meter conditions:** Voltmeter probes at 4 and O after defrost timer is manually rotated out of defrost cycle.

   Why make this check?

   What does a meter reading of 120 VAC indicate?

Assignment Sheet 2

9. **Test meter conditions:** Ohmmeter probes at T_1 and T_2 with one end disconnected..

Why make this check?

What does a meter reading showing 0Ω indicate?

10. **Test meter conditions:** Voltmeter probes at P and O with fresh food compartment door closed or fan button switch pushed.

Why make this check?

What does a meter reading of 0 volts indicate?

11. **Test meter conditions:** Voltmeter probes at L on start relay and C on compressor.

Why make this check?

What does a meter reading of 120 VAC indicate?

12. **Test meter conditions:** Ohmmeter probes on C and R on compressor with start relay removed.

Why make this check?

Assignment Sheet 2

What does a meter reading of ∞ indicate?

____

____

Part II

Directions: Review your answers to the questions in the previous problems. Make a list of components that should be serviced to put the appliance back in good operating condition. When you list a component, also indicate what needs to be done to that component. You may also consult the troubleshooting chart in Student Supplement 1 to complete this assignment.

1. Component ____

   Service Required ____

2. Component ____

   Service Required ____

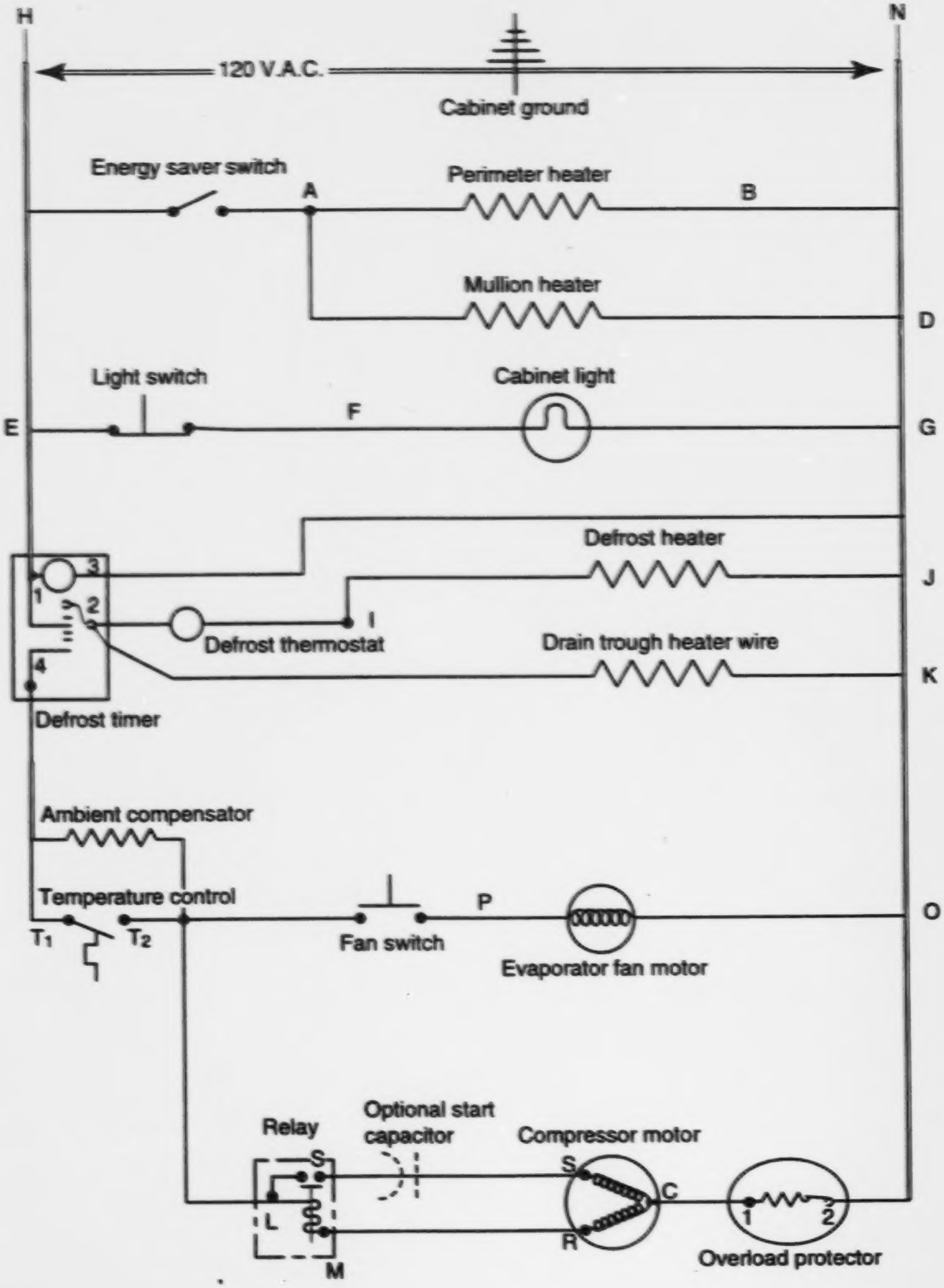
3. Component ____

   Service Required ____

4. Component ____

   Service Required ____

Assignment Sheet 2


H
N
120 V.A.C.
Cabinet ground
Energy saver switch
A
Perimeter heater
B
Mullion heater
D
Light switch
Cabinet light
E
F
G
Defrost heater
J
3
1
2
I
Defrost thermostat
Drain trough heater wire
K
4
Defrost timer
Ambient compensator
Temperature control
T1
T2
Fan switch
P
O
Evaporator fan motor
Relay
S
L
M
Optional start capacitor
Compressor motor
S
C
R
1
2
Overload protector

Refrigerator and Freezer Service and Repair
Unit 4

Assignment Sheet 3—Select Filter-Driers for Given Applications

Name ______________________________ Overall Rating ____________

Evaluation Criteria	**Rating**
Number of answers attempted	______
Number of correct answers	______

Directions: Examine the Catch-All® specifications from Sporlan and the Parker specifications from the Johnstone catalog that accompany this assignment sheet. Reference the materials as needed to answer the following questions.

Note: Reference the Sporlan materials to answer this first group of questions.

1. In planning a filter-drier replacement, you note that the inlet is male and the outlet is female. What filter-drier would you select?

   Answer: ______________________________

2. Why would a C-032-CAP filter-drier have an extended connection?

   Answer: ______________________________

3. A C-033-S filter drier indicates what type of filter, what volume of dessicant, and what size and type of connections?

   Answer: ______________________________

4. If the last two digits in a filter number indicate the fitting size in eighths of an inch, what is the fitting size of the designation C-082-S?

   Answer: ______________________________

5. How many ounces of refrigerant would you need to add to a refrigerant charge if you use a C-032-CAP filter with R-12?

   Answer: ______________________________

6. How many ounces of refrigerant would you need to add to a refrigerant charge if you use a C-032-CAP filter with R-134a?

   Answer: ______________________________

   Note: Reference the Johnstone materials for the remaining questions in this assignment.

Assignment Sheet 3

7. You are replacing a 1/3 hp compressor in a unit that uses R-12. What liquid line drier would you install if you have 8 inches of space available at the end of the liquid line?

   Answer: ____________________

8. You are replacing a 1/2 hp compressor in a unit that uses R-134a. What liquid line drier would you install if you have a 1/4 inch liquid line?

   Answer: ____________________

9. What is the diameter of a B10-164 drier?

   Answer: ____________________

Assignment Sheet 3

The following charts are from the Johnstone Supply Fall/Winter Catalog 1995 and are reprinted with permission

Parker Driers for Units up to 2 Tons

Notes: B11-383 and B10-162 are non directional
100% molecular sieve
Tubes can be easily cut, flared or bent for job application
Superior mesh screens provide added filtering capacity
Fully guaranteed against defects in material and workmanship

			Water Capacity in Drops				Tonage		
			R12		R22		R12 & R134a	R22	Order Stock #
OD	Length	Inlet/Outlet Size (OD)	75°	125°	75°	125°			
3/4"	7 3/8"	1/4"	37.5	34.1	34.5	32.0	1/3	1/2	B-11-383
3/4"	9 1/4"	1/4"	37.5	34.1	34.5	32.0	1/3	1/2	B-10-162
1"	9 1/4"	1/4"	72.0	65.0	65.0	61.0	3/4	1	B-10-163
1 3/16"	9 3/4"	5/16"	112.5	102.5	103.5	95.8	1	2	B-10-161

Parker Access Valve Drier

Notes: Same features as other driers, plus:
150 mesh screen
Scharader type valve for charging and evacuating
Fused end grooved for easy break-off
Compact

1"	11"	1/4"	72.9	65.0	66	61	1	2	B-10-164

Assignment Sheet 3

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Liquid Line Type		Suction Line Type	Connection Size	Volume of Desiccant	Length Inches		Solder Socket Depth Inches	Diameter of Body Inches	Shipping Weight
SAE Flare	ODF Solder	ODF Solder	Inches	Cu. In.	SAE Flare	ODF Solder			Lbs.
C-032	C-032-S	—	1/4	3	4.19	3.81	0.38	1.75	1/2
—	C-032-CAP C-032-CAP-T	—	Extended 1/4 Male		—	5.81	—		
C-032-F	—	—	1/4 Male—Inlet 1/4 Female—Outlet		3.81	—	—		
C-032-FM	—	—	1/4 Female—Inlet 1/4 Male—Outlet		3.81	—	—		
C-033	C-033-S	—	3/8		4.69	3.88	0.44		
C-052	C-052-S	—	1/4	5	4.75	4.19	0.38	2.44	3/4
—	C-0525-S	—	5/16		—	4.38	0.44		
C-053	C-053-S	—	3/8		5.19	4.31	0.44		
C-082	C-082-S	—	1/4	9	5.62	5.12	0.38	2.62	1 1/4
—	C-0825-S	—	5/16		—	5.31	0.44		
C-083	C-083-S	—	3/8		6.06	5.25	0.44		
C-084	C-084-S	C-084-S-T-HH	1/2		6.31	5.44	0.50		
C-162	C-162-S	—	1/4	16	6/25	5.75	0.38	3.00	1 3/4
—	C-1625-S	—	5/16		—	5.94	0.44		
C-163	C-163-S	—	3/8		6.75	5.88	0.44		
C-164	C-164-S	C-164-S-T-HH	1/2		6.94	6.00	0.50		
C-165	C-165-S	C-165-S-T-HH	5/8		7.25	6.31	0.62		
—	—	C-166-S-T-HH	3/4		—	6.75	0.62		
—	C-167-S	C-167-S-T-HH	7/8		—	6.93	0.75		
C-303	C-303-S	—	3/8	30	9.69	8.98	0.44	3.00	3 1/2
C-304	C-304-S	—	1/2		9.88	9.00	0.50		
C-305	C-305-S	C-305-S-T-HH	5/8		10.19	9.25	0.62		
—	C-306-S	C-306-S-T-HH	3/4		—	9.65	0.62		
—	C-307-S	C-307-S-T-HH	7/8		—	9.80	0.75		
—	C-309-S	C-309-S-T-HH	1 1/8		—	9.75	0.88		
C-413	—	—	3/8	41	9.56	—	—	3.50	4 1/2
C-414	C-414-S	—	1/2		9.94	9.05	0.50		
C-415	C-415-S	—	5/8		10.25	9.35	0.62		
—	C-417-S	C-417-S-T-HH	7/8		—	9.81	0.69		
—	C-419-S	C-419-S-T-HH	1 1/8		—	9.75	0.91		
—	—	C-437-S-T-HH	7/8	48	—	10.38	0.75	4.75	8
—	—	C-439-S-T-HH	1 1/8		—	10.62	0.94		
—	—	C-4311-S-T-HH	1 3/8		—	10.94	1.00		
—	—	C-4313-S-T-HH	1 5/8		—	10.94	1.06		
—	C-607-S	C-607-S-T-HH	7/8	60	—	16.00	0.75	3.00	6
—	C-609-S	C-609-S-T-HH	1 1/8		—	16.00	0.91		

Listed by Underwriters' Laboratories Inc. — Guide-SMGT-File No. SA-1758A & B and Canadian Standards Association — File LR-19853.

SIGNIFICANCE OF THE TYPE NUMBER. . . . .

The letters and numerals in the Catch-All type number each have a significance.

"C" indicates Catch-All.

"FIRST TWO DIGITS" indicate the cubic inches of desiccant in the given drier size.

"LAST ONE OR TWO DIGITS" indicates the fitting size in eighths. For example: a "3" indicates 3/8" fitting size; a "25" indicates a 5/16" fitting size.

"NO LETTER" following the last digit indicates an SAE flare fitting.

"–S" following the last digit indicates an ODF Solder fitting. Other suffix letters indicate special qualities. Example:

"–T" indicates a pressure tap consisting of a Schrader type access valve on the inlet end of the Catch-All.

"–HH" indicates a charcoal style core for wax removal and cleanup after a hermetic motor burnout.

"–F" indicates a female flare outlet fitting with a male flare inlet fitting.

"–FM" indicates a female flare inlet fitting with a male flare outlet fitting.

"–CAP" indicates a Catch-All particularly designed for installation on capillary tube systems. The fittings (a1/4" OD copper tube brazed into each end of the Catch-All) permit inserting the capillary tube into this 1/4" tube, pinching down, and soldering to make the connections.

The type numbers used on replaceable core Catch-Alls have the same basic significance.

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Assignment Sheet 3

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Ounces of Refrigerant by Weight @ 100°F

Series Type Number	R-12	R-134a
C-030	2.1	1.9
C-050	5.3	4.9
C-080	7.6	6.9
C-160	12.0	11.0
C-300	19.2	17.6
C-410	27.0	24.7

TYPE CATCH-ALL	AMOUNT OF DESSICANT Cu. In.	SELECTION RECOMMENDATIONS Nominal Ratings (Tons)			
		REFRIGERATION		AIR CONDITIONING	
		Commercial & Low Temperature Equipment		Field Replacement or Field Build Up Systems	
		12	22	12	22
C-032 Series C-033 C-033S	3	1/4	1/4	1/3	1/3
C-052 Series C-052S C-053 C-053-S	5	1/3	1/3	3/4	3/4
		1/3	1/3	1	2
C-082 C-082S	9	1/2	1/2	3/4	1
C-083 C-083-S		1	1	2	2
C-084 C-084S		1 1/2	1 1/2	2	2

Refrigerator and Freezer Service and Repair
Unit 4

Assignment Sheet 4—Select Compressors for Given Applications

Name ____________________ Overall Rating ____________

Evaluation Criteria	**Rating**
Number of answers attempted	______
Number of correct answers	______

Directions: Examine the materials that accompany this assignment sheet. In the materials, you'll find a cross reference guide for selecting replacement refrigerator and freezer compressors, and specifications for 1/8 HP to 1/3 HP compressors. Consult the materials as needed to answer the following questions.

1. Assume you are working on an appliance that has a 1/4 hp compressor without an oil cooler, and you need to order a comparable compressor.

   a. What are the Johnstone numbers of the possible replacements?

   Answer: ____________________

   b. What is the Btu rating of the replacement compressor with an evaporator temperature of −10°F?

   Answer: ____________________

   c. What are the dimensions of the replacement compressor?

   Answer: ____________________

   d. What size is the suction tubing connection? the discharge tubing connection? the process tube?

   Answer: suction ________ discharge ________ process tube ________

2. Assume you are working on a domestic refrigerator-freezer with Btu rating of 840.

   a. What is the Johnstone number of the compressor you would select to replace the compressor on this unit?

   Answer: ____________________

   b. What is the hp of the replacement compressor?

   Answer: ____________________

   c. What is the amperage rating of the replacement compressor?

   Answer: ____________________

Assignment Sheet 4

The following charts are from the Johnstone Supply Fall/Winter Catalog 1995 and are reprinted with permission

Embraco Compressors 1/8-1/3 HP

Notes: For R12 and interim blend applications
Charged with alkylbenzene oil
B-81-347 and B81-357 have start capacitors (high starting torque)
Hermetically sealed and fully charged with oil
B81-262 through 265 are direct replacement of Whirlpool compressors (see cross reference)
Single-phase, 115 volts
Ideal replacement

Dimensions			Tube Connection ID Size			Oil Cooler ID	Order Stock #
Height	Length	Base	Suction	Discharge	Process		
7.28"	8.42"	6 1/2" x 4"	1/4"	3/16"	1/4"	N/A	B-81-344
7.28"	8.42"	6 1/2" x 4"	1/4"	3/16"	1/4"	N/A	B-81-262
7.72"	9.41"	6 1/2" x 4"	5/16"	1/4"	1/4"	N/A	B-81-345
7.72"	10.24"	6 1/2" x 4"	5/16"	1/4"	1/4"	3/16"	B-81-263
7.50"	10.25"	6 1/2" x 4"	5/16"	1/4"	1/4"	N/A	B-81-346
7.50"	10.75"	6 1/2" x 4"	5/16"	1/4"	1/4"	N/A	B-81-347
8.11"	10.04"	6 1/2" x 4"	5/16"	1/4"	1/4"	1/4"	B-81-264
8.81"	10.24"	6 1/2" x 4"	1/4"	1/4"	1/4"	1/4"	B-81-265
8.00"	10.75"	6 1/2" x 4"	5/16"	1/4"	1/4"	N/A	B-81-357

Mfg. Part #	HP	Low Temp Btu −10°	High Temp Btu +45°	Capacitor	Relay Overload	FLA	Order Stock #
PW4.5K11	1/8	397	1465	G22-657	B11-909	3.10	B81-344
PW5.5K14	1/6	515	1845	G22-005	B11-910	5.10	B81-262
FF6BK	1/5	655	2345	G22-656	B11-912	3.00	B81-345
FF8.5BKW	1/4	855	2665	G22-005	B11-913	4.50	B81-263
FF10BK	1/4	935	2985	G22-005	B11-916	5.30	B81-346
FF10BX	1/4	935	3000	G22-834	B11-914	5.30	B81-347
FF11.5BKW	1/4+	1150	3645	G22-005	B11-915	6.20	B81-264
FFL12BKW	1/3	1300	4000	G22-005	B11-915	4.15	B81-265
FFL12BX	1/3	1390	4375	G22-657	B11-917	11.20	B81-357

Refrigerator and Freezer Service and Repair
Unit 4

Job Sheet 1—Perform Maintenance on a Small Refrigerated Appliance

Name ______________________________ Attempt Number __________

Date ______________________________ Overall Rating __________

Evaluation Criteria	**Rating**
Condenser cleaned	______
Refrigerator level and clean	______
Pressures and temperatures to specifications	______

A. Tools and materials

Refrigerator-freezer or freezer as selected by instructor
Refrigeration technician's hand tools
Vacuum cleaner
All purpose cleaner
Cleaning rags and a water bucket
Assorted brushes
Manifold gauge set
Remote bulb thermometer (electric or electronic recommended)

B. Procedure

☐ 1. Check with user, service work order, or service records for any complaints or anything unusual about the performance of the appliance.

☐ 2. Visually check appearance, general condition, and manner in which the appliance was installed.

Note: Follow only procedures that apply to the appliance you are servicing.

☐ 3. Note anything that might affect the appearance or operation of the appliance such as:

a. proper installation clearances above and around the appliance.

b. obstructions placed above or around the cabinet.

c. doors, handles, or hinges out of alignment or broken.

d. dirt, lint, or other obstructions in the toe plate grille.

☐ 4. Listen for sounds of compressor running, fans running, or any other usual or unusual noises.

Job Sheet 1

☐ 5. Open the doors and visually inspect the interior for such things as:

  a. door gaskets or other dividers not sealed properly.

  b. general cleanliness and indications of how the appliance has been maintained.

  c. amount and arrangement of items in the compartments.

  d. condition of the contents of each compartment.

  e. location of controls, air circulation openings, and general configuration of space within the compartments.

  f. presence and location of ice or moisture.

  g. presence and location of an ice maker, and/or ice or water fixtures in the door.

☐ 6. Locate and push the fan switch button and listen for the fan to stop.

☐ 7. Locate and push the light switch button and look for the light to go out.

Note: Fan and light may be controlled by the same button.

☐ 8. Locate data plate and record all appropriate information on your service work order.

Note: The data plate may be inside the compartments or behind the toe plate.

☐ 9. Remove the toe plate and set it aside for cleaning.

☐ 10. Use a light to see if the condenser is beneath the appliance, and if it needs cleaning.

☐ 11. Pull the appliance out far enough to provide access behind, paying attention not to damage any connecting water or electrical lines.

Note: This may require adjusting feet or loosening a braking device and take care not to damage the floor or flooring as you move the appliance.

☐ 12. Unplug the appliance or turn off electricity to it.

☐ 13. If the condenser was not underneath the appliance, look for one on the back.

☐ 14. If there is a cover on the back of the appliance over the compressor compartment, remove it.

☐ 15. Locate the condenser fan motor, if present, check for oil ports, check bearings, and check condition of fan blade.

Job Sheet 1

☐ 16. Observe general condition of wiring, shrouds, dividers, and tubing in the compartment.

☐ 17. Inspect water line and valve indications of water leaks.

☐ 18. Use vacuum cleaner, rags, brushes, and cleaning supplies to clean the condenser, fan blade, and compressor compartment.

☐ 19. Make any minor repairs as required on the back of or underneath the appliance.

☐ 20. Clean door gaskets and seals and switch buttons and anything else that might affect the operation of the appliance.

☐ 21. Make minor repairs to the interior which affect the operation or use of the appliance.

☐ 22. If a low-side access valve is available, hook a manifold gauge set to it, and record static pressures.

☐ 23. Replace compressor compartment cover with one or two screws, or prop it up against the opening.

☐ 24. Plug the appliance in or turn on the electricity.

☐ 25. If compressor does not start, turn cold control slowly to its coldest position, noting at what position the compressor starts; this will tell whether or not the cold control is working.

☐ 26. Place thermometers or remote thermometer sensors in each major compartment.

☐ 27. Observe changes in the temperatures and pressures over a 30 or 45 minute period, and record them on your service work order.

☐ 28. While you are waiting, make any minor repairs to flooring or surroundings which might affect operation of the appliance.

Note: Many customers will appreciate it if you will clean or allow them to clean the area behind the appliance.

☐ 29. Clean the toe plate and put it back in place.

☐ 30. If temperatures and pressures appear to be normal, remove the manifold gauge set, put rear cover back in place, and move appliance back to its original position.

☐ 31. Check door gasket seals and realign doors and hinges if necessary.

☐ 32. Clean exterior of the appliance of any service-related smudges.

Job Sheet 1

Note: If this is a company owned appliance being prepared for resale, more extensive cleaning inside and out will be required.

☐ 33. Make a list of any potential problems or anything else that might be of interest to the customer.

☐ 34. Complete the service work order and any other related paperwork.

☐ 35. Have your instructor/customer inspect your work.

Evaluator's Comments: ____________________

____

____

ACRD-123

Job Sheet 1

Service Work Order

Customer's Name ______________________________

Customer's Address ______________________________

Brief description of problem ______________________________

____

____

Time and date service or repair started ______________________________

Time and date service or repair ended ______________________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ______________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ______________

What amount of refrigerant was added? ______________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type? ________ Amount? ________

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ______________ Date ______________

Job Sheet 1

Service Work Order

Evaluation of unit condition and general performance:

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
e. Liquid line pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
f. Evaporator temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
g. Other compartment temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
h. Condenser air temperatures at end of cycle	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
i. Additional information			
j. Additional information			

k. Technician signature ____________________ Date ____________

Refrigerator and Freezer Service and Repair
Unit 4

Job Sheet 2—Remove and Replace Breaker Trim

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
Refrigerator and breaker trim warmed for removal	_____
Insulation inspected and replaced as required	_____
New breaker trim installed and seal verified	_____

A. Tools and materials

Refrigerator as selected by instructor
Wood block, approximately 6" x 4" x 1"
Refrigeration technician's hand tools
Replacement breaker trim as required
Replacement insulation as required
Clean towel and bucket for hot water, if required
Safety glasses

B. Procedure

☐ 1. Put on safety glasses.

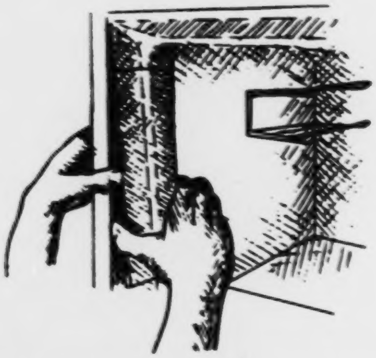
☐ 2. Disconnect the refrigerator from electrical power.

☐ 3. Open the refrigerator doors and allow the refrigerator to warm to room temperature.

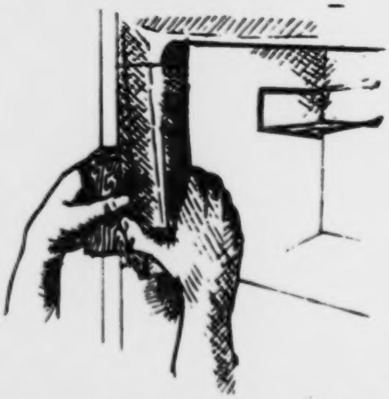
☐ 4. Place a towel in hot water, wring it out, and place it on the breaker trim to speed the job a bit.

☐ 5. Start at the bottom front edge and remove the side breakers first.

Job Sheet 2

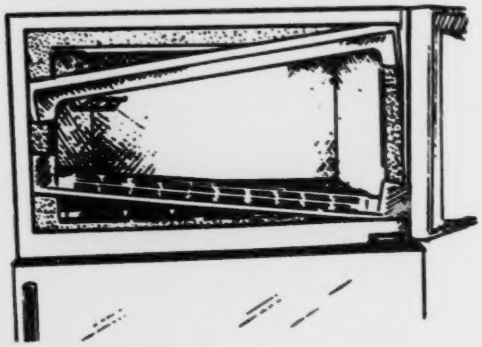


☐ 6. Use a wood block to gently pry the breaker trim loose if it appears to be stuck, but do not pry on the trim with a screwdriver because you may not only break the trim, you could easily scar the refrigerator.



☐ 7. Pull the trim forward to disengage it from the liner, and be careful not to damage the light switch or the wires that are covered by the trim.

☐ 8. After the side trim is removed, pull down on one end of the top trim to remove it, and pull up on the bottom trim to remove it.



☐ 9. Lay trim aside for probable reuse.

Job Sheet 2

☐ 10. Check the insulation for wetness; if it is wet, remove it and evaluate its condition; if it can be reused, dry it out and use it, or if it needs to be replaced, replace it.

☐ 11. Have your instructor check the insulation after your evaluation.

☐ 12. Replace insulation.

☐ 13. Replace the bottom trim by inserting one end first and then pushing back and down to get the trim to slip under the liner; you may have to twist the trim slightly to get it to fit.

☐ 14. Replace the top trim by starting at one end first and then pushing back and up to slip the trim under the liner.

☐ 15. Replace the side trim by starting at the top and back of the trim first.

☐ 16. Push back on the trim and insert the front of the trim behind the cabinet flange clips.

☐ 17. Clean finger prints or other marks from the trim and cabinet.

☐ 18. Open and close the doors a time or two to check for a proper seal between the doors and the trim.

☐ 19. Plug the refrigerator back into the electrical outlet, if directed.

☐ 20. Have your instructor check your breaker trim replacement.

☐ 21. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

____

____

Refrigerator and Freezer Service and Repair
Unit 4

Job Sheet 3—Troubleshoot Selected Problems With Refrigerators and Freezers

Name ______________________________ Attempt Number __________

Date ______________________________ Overall Rating __________

Evaluation Criteria	Rating
Customer complaints checked	______
Standard troubleshooting employed	______
Records properly made	______

A. Tools and materials

Refrigerator and/or freezers as selected by instructor
Refrigeration technician's hand tools
Manifold gauge set
Test instruments and equipment as needed/desired
Safety glasses

Special Directions

Follow these procedures to troubleshoot three or more appliances as directed by your instructor. From your instructor, obtain a copy of this job sheet and service work order for each appliance assigned.

B. Procedure

☐ 1. Check the service work order for information about the appliance and customer complaints or comments.

☐ 2. Ask your instructor or customer for additional information about recent operating characteristics.

☐ 3. List potential problems that you can identify from written or oral information.

Hint: A troubleshooting guide may be helpful.

____

____

____

Job Sheet 3

☐ 4. Use standard troubleshooting procedures and charts or guides to identify the specific cause(s) of the problem(s) and write the results here:
____
____
____

☐ 5. Describe the service and parts necessary to put the appliance in proper working order.
____
____
____

☐ 6. Record all necessary information on the service work order that accompanies this job sheet.

☐ 7. Report your findings to your instructor.

☐ 8. Perform corrective service if so directed.

☐ 9. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ________________________________
____
____

Job Sheet 3

Service Work Order

Customer's Name ____________________

Customer's Address ____________________

Brief description of problem ____________________

____

____

Time and date service or repair started ____________________

Time and date service or repair ended ____________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No
If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.
☐ Recycled on site and returned in total to the system at end of service.
☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ____________________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No
If refrigerant was added, what refrigerant was used? ____________________
What amount of refrigerant was added? ____________________
Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No
Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type?__________ Amount? __________

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No
Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ____________________ Date ____________________

Job Sheet 3

Service Work Order

Evaluation of unit condition and general performance:

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
e. Liquid line pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
f. Evaporator temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
g. Other compartment temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
h. Condenser air temperatures at end of cycle	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
i. Additional information			
j. Additional information			
k. Technician signature ______ Date ______			

Refrigerator and Freezer Service and Repair
Unit 4

Job Sheet 4—Check the Efficiency of a Compressor

Name ______________________ Attempt Number ________

Date ______________________ Overall Rating ________

Evaluation Criteria	Rating
Manifold gauge properly installed	______
Ammeter or wattmeter properly installed	______
Pressures and system current readings made	______
System evaluation prepared in writing	______

A. Tools and materials

Appliance as selected by instructor
Manufacturer's operating conditions chart or equivalent
Safety glasses
Shop towels
Refrigeration technician's hand tools
Manifold gauge set
Ammeter or wattmeter
System access valves or adapters

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Attach manifold gauge set to high and low sides of the system, attaching valves or adapters as needed.

☐ 3. Connect ammeter or wattmeter so that system current or wattage can be read.

☐ 4. Start the system and allow pressures to stabilize.

☐ 5. Evaluate pressure readings.

Job Sheet 4

☐ 6. Look for a combination of the following conditions to indicate an inefficient compressor:

  a. higher than normal low-side pressure.

  b. lower than normal high-side pressure.

  c. lower than normal current draw or power consumption.

☐ 7. Record your evaluation of the compressor efficiency:

____

____

____

☐ 8. Have your instructor check your findings.

☐ 9. Remove the manifold gauge set and any adapters used.

☐ 10. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

____

____

Refrigerator and Freezer Service and Repair
Unit 4

Job Sheet 5—Replace an Evaporator Fan Motor

Name ____________________ Attempt Number __________

Date ____________________ Overall Rating __________

Evaluation Criteria	Rating
Original fan motor safely and properly removed	______
Original fan motor checked to verify condition	______
Blade setting on shaft measured and recorded	______
Replacement motor checked and properly installed	______

A. Tools and materials

Small refrigerated appliance w/forced-air evaporator
Refrigeration technician's hand tools
Manifold gauge set
Replacement evaporator fan motor
Ammeter or wattmeter
Test cord
Thermometers
Small container for parts
Shop towels
Safety glasses

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Disconnect electrical power to the appliance.

☐ 3. Disassemble appliance as necessary to gain access to the evaporator fan motor.

Note: In two-door refrigerator-freezers, the evaporator and evaporator fan assembly will usually be accessed through the freezer compartment, and in other applications you can usually see the fan blade or shroud which indicates the fan motor location.

☐ 4. Disconnect wiring from motor.

☐ 5. Remove the motor while observing closely how the motor is mounted, and marking parts as necessary to facilitate replacement.

Job Sheet 5

☐ 6. Place all loose, small parts in a container.

☐ 7. Use an ohmmeter to check the motor.

☐ 8. Check motor bearings by moving the shaft side to side and observing if there is any play.

☐ 9. If motor checks okay electrically, and the shaft has no play, use a test cord to connect the motor to the proper power source to see if the motor will run.

☐ 10. If the motor runs, oil the bearings and use an ammeter or a wattmeter to measure amperage or power consumption, and compare your readings with those given on the motor or the appliance data plate.

☐ 11. If readings are equal to or better than specifications, clean the motor thoroughly and replace it in the appliance.

☐ 12. If the motor fails any of the previous checks, install a replacement motor.

☐ 13. Measure the distance from the motor that the fan blade is mounted on the shaft, if it is not mounted on the hub; record the distance here: ____________________

☐ 14. Remove the fan blade from the original motor.

☐ 15. Check the replacement motor to make sure it is the same or the equivalent of the original motor, including:

   a. electrical ratings.

   b. physical dimensions.

   c. shaft dimensions.

   d. direction of motor rotation.

☐ 16. Read the directions accompanying the replacement motor, particularly if the motor is not an exact replacement.

Note: Directions with multipurpose replacement motors will contain directions and adapters for adapting the motor to different mountings.

☐ 17. Install the fan blade onto the new motor using the measurement you made earlier, if required.

☐ 18. Install the motor in the appliance.

☐ 19. Have your instructor check your work.

☐ 20. Reassemble the appliance and clean as necessary.

Job Sheet 5

☐ 21. Start the system and record temperature and pressure readings on the service work order that accompanies this job sheet.

☐ 22. Have your instructor check your results.

☐ 23. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

____

____

ACRD-139

Job Sheet 5

Service Work Order

Customer's Name ______________________________

Customer's Address ______________________________

Brief description of problem ______________________________

____

____

Time and date service or repair started ______________________________

Time and date service or repair ended ______________________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ______________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ______________

What amount of refrigerant was added? ______________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type?________ Amount? ______

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ______________________ Date ______________

Job Sheet 5

Service Work Order

Evaluation of unit condition and general performance:

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
e. Liquid line pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
f. Evaporator temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
g. Other compartment temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
h. Condenser air temperatures at end of cycle	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
i. Additional information			
j. Additional information			

k. Technician signature ________________ Date ________

Refrigerator and Freezer Service and Repair
Unit 4

Job Sheet 6—Replace a Condenser Fan Motor

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
Original fan motor safely and properly removed	______
Original fan motor checked to verify condition	______
Blade setting on shaft measured and recorded	______
Replacement motor checked and properly installed	______

A. Tools and materials

Small refrigerated appliance w/forced-air condenser
Refrigeration technician's hand tools
Manifold gauge set
Replacement condenser fan motor
Ammeter or wattmeter
Test cord
Thermometers
Small container for parts
Shop towels
Safety glasses

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Disconnect electrical power to the appliance.

☐ 3. Disassemble appliance as necessary to gain access to the condenser fan motor.

Note: In most refrigerators, the condenser and condenser fan assembly will be located underneath the appliance, and be accessible through an opening in the back of the appliance.

☐ 4. Disconnect wiring from motor.

☐ 5. Remove the motor while observing closely how the motor is mounted, and marking parts as necessary to facilitate replacement.

☐ 6. Place all loose, small parts in a container.

Job Sheet 6

☐ 7. Use an ohmmeter to check the motor.

☐ 8. Check motor bearings by moving the shaft side to side and observing if there is any play.

☐ 9. If motor checks okay electrically, and the shaft has no play, use a test cord to connect the motor to the proper power source to see if the motor will run.

☐ 10. If the motor runs, oil the bearings and use an ammeter or a wattmeter to measure amperage or power consumption, and compare your readings with those given on the motor or the appliance data plate.

☐ 11. If readings are equal to or better than specifications, clean the motor thoroughly and replace it in the appliance.

☐ 12. If the motor fails any of the previous checks, install a replacement motor.

☐ 13. Measure the distance from the motor that the fan blade is mounted on the shaft, if the blade is not mounted directly to the hub; record the distance here: ____________________.

☐ 14. Remove the fan blade from the original motor.

☐ 15. Check the replacement motor to make sure it is the same or the equivalent of the original motor, including:

   a. electrical rating.

   b. physical dimensions.

   c. shaft dimensions.

   d. direction of motor rotation.

☐ 16. Read the directions accompanying the replacement motor, particularly if the motor is not an exact replacement.

   Note: Directions with multipurpose replacement motors will contain directions and adapters for adapting the motor to different mountings.

☐ 17. Install the fan blade onto the new motor using the measurement you made earlier, if required.

☐ 18. Install the motor in the appliance.

☐ 19. Have your instructor check your work.

☐ 20. Reassemble the appliance and clean as necessary.

Job Sheet 6

☐ 21. Start the system and record temperature and pressure readings on the service work order that accompanies this job sheet.

☐ 22. Have your instructor check your results.

☐ 23. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

Job Sheet 6

Service Work Order

Customer's Name ______

Customer's Address ______

Brief description of problem ______

______

______

Time and date service or repair started ______

Time and date service or repair ended ______

Materials or equipment used to complete service or repair (continue list on back of form if needed)

______

______

______

______

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ______

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ______

What amount of refrigerant was added? ______

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type? ______ Amount? ______

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ______ Date ______

Job Sheet 6

Service Work Order

Evaluation of unit condition and general performance: ____________________

____

____

____

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
e. Liquid line pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
f. Evaporator temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
g. Other compartment temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
h. Condenser air temperatures at end of cycle	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
i. Additional information			
j. Additional information			

k. Technician signature ____________________ Date ____________

Refrigerator and Freezer Service and Repair
Unit 4

Job Sheet 7—Install a Process Tube Adapter on a Refrigerator or Freezer

Name ______________________ Attempt Number ________

Date ______________________ Overall Rating ________

Evaluation Criteria	**Rating**
Refrigerant removed from system per EPA regulations	______
Process tube adapter properly installed	______
System evacuated and recharged per EPA regulations	______
Operating Conditions Chart completed for unit evaluation	______

A. Tools and materials

Refrigerator or freezer as selected by instructor
Appropriate service literature
Manifold gauge set
Process tube adapter
Pinch off tool
Copper cleaning supplies
Soldering/brazing torch
Flux and soldering/brazing rod as required
Refrigeration technician's hand tools
Thermometer(s) with remote sensor(s)
Safety glasses and colored safety glasses
Clean shop cloth(s)
Service Work order w/Operating Conditions Chart

B. Procedure

☐ 1. Consult customer/instructor for special information that may affect servicing.

☐ 2. Obtain manufacturer's operating instructions or troubleshooting information, if available.

☐ 3. Put on safety glasses.

☐ 4. Locate the process tube on the compressor or the suction line.

☐ 5. Install a clamp-on line tap valve on the process tube, remove the refrigerant according to EPA guidelines, and remove line tap valve.

Job Sheet 7

Note: On a service call, any service or repairs needed would be completed at this time.

☐ 6. Clean the process tube on the compressor side of the pinch off point and cut off the end of the tube.

☐ 7. If the process tube is too short to permit adapter attachment, braze on an extension, and be sure to observe torch safety and wear colored safety glasses as you braze.

☐ 8. Select an adapter to fit the diameter of the process tube.

☐ 9. Attach the adapter to the process tube according to directions that come with the adapter.

☐ 10. Attach the low-side hose of the manifold gauge to the service opening on the process tube adapter.

☐ 11. Replace the liquid line drier.

☐ 12. Leak test, evacuate the system, and recharge the system with the specified amount and type of refrigerant.

Note: EPA regulations apply to evacuation and recharging activities.

☐ 13. Have your instructor check your installation.

☐ 14. Start the system and record your temperature/pressure readings in the operating conditions chart on the service work order that accompanies this job sheet.

☐ 15. Report your findings to and discuss them with your instructor.

☐ 16. Use the pinch off tool to pinch off the process tube.

☐ 17. Remove the manifold gauge set and then remove the process tube adapter.

☐ 18. Braze the end of the process tube where you pinched it off, and be sure to follow brazing safety procedures and wear colored safety glasses.

☐ 19. Have your instructor inspect your work.

☐ 20. Clean up area and return tools and materials to proper storage.

☐ 21. Report your findings to and discuss them with your customer/instructor.

☐ 22. Complete required paper work and turn it into your dispatcher/instructor.

Job Sheet 7

Evaluator's Comments: ____________________

ACRD-151

Job Sheet 7

Service Work Order

Customer's Name ______________________________

Customer's Address ______________________________

Brief description of problem ______________________________

____

____

Time and date service or repair started ______________________________

Time and date service or repair ended ______________________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ______________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ______________

What amount of refrigerant was added? ______________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type?________ Amount? ______

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ______________ Date ______________

Job Sheet 7

Service Work Order

Evaluation of unit condition and general performance:

____

____

____

____

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
e. Liquid line pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
f. Evaporator temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
g. Other compartment temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
h. Condenser air temperatures at end of cycle	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
i. Additional information			
j. Additional information			
k. Technician signature ____________________ Date __________			

Refrigerator and Freezer Service and Repair
Unit 4

Job Sheet 8—Repair a Leak in an Aluminum Evaporator Using Paste Epoxy

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	Rating
Patch area cleaned and prepared	______
Epoxy mixed and properly applied	______
Patch evaluated with leak check	______
Drier replaced, system evacuated and charged	______
Operating pressures and temperatures recorded	______

A. Tools and materials

Small refrigerated appliance w/aluminum evaporator
Refrigeration technician's hand tools
Vacuum pump
Manifold gauge set
Refrigerant recovery equipment
Dry nitrogen cylinder w/regulator
Leak detector
Hand-held drier
Filter-drier to system specifications
Find grade sand cloth or stainless steel brush
Epoxy kit compatible w/system refrigerant
Acetone (optional)
Shop towels
Gloves (optional)
Safety glasses
Small, clean piece of cardboard or sheet metal

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Locate the specific point where the leak is located on the evaporator coil.

Note: This may entail pressurizing and leak checking.

☐ 3. Recover any refrigerant that remains in the system, or release the pressure left from leak checking.

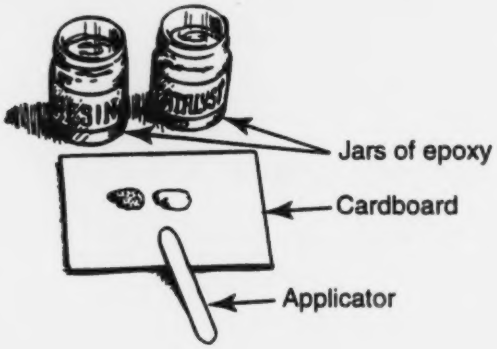
Job Sheet 8

☐ 4. Use a stainless steel brush, sand cloth, and a shop towel to thoroughly clean the surface around the leak at least 1/2 inch away from the leak.

Note: A final cleaning of the patch area with acetone may be helpful, but if you use acetone, be extra careful because it is highly flammable.

☐ 5. If directions in the epoxy kit differ from the directions in this procedure, follow the guidelines in the kit.

☐ 6. Mix equal amounts of resin and catalyst on a clean piece of cardboard or sheet metal until the mixture has a single consistency.



☐ 7. Apply the epoxy mixture over the patch area until it leaves an even coat with outside edges that fully adhere to the aluminum.

☐ 8. Use cleaning fluid to clean any excess epoxy from the patch area.

☐ 9. Attach gauge set and vacuum pump.

☐ 10. Pull 2 to 4 inches of vacuum on the system.

☐ 11. Place the blow drier to warm the patch area for approximately two hours.

☐ 12. Allow system to set for the amount of time recommended by the epoxy kit manufacturer.

☐ 13. Pressurize and leak check.

☐ 14. If the patch leaks, check with your instructor about repeating the procedure.

☐ 15. If the patch does not leak, replace the liquid line drier, and then evacuate and charge the system.

Note: Refer to Job Sheets 12, 13, and 14 as needed.

☐ 16. Record temperatures and pressures on the service work order that accompanies this job sheet.

Job Sheet 8

☐ 17. Have your instructor check your results.

☐ 18. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

ACRD-157

Job Sheet 8

Service Work Order

Customer's Name ______________________________

Customer's Address ______________________________

Brief description of problem ______________________________

____

____

Time and date service or repair started ______________________________

Time and date service or repair ended ______________________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ______________________________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ______________________________

What amount of refrigerant was added? ______________________________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type? __________ Amount? __________

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ______________________________ Date ______________

Job Sheet 8

Service Work Order

Evaluation of unit condition and general performance:

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
e. Liquid line pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
f. Evaporator temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
g. Other compartment temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
h. Condenser air temperatures at end of cycle	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
i. Additional information			
j. Additional information			

k. Technician signature ____________________ Date ____________

Refrigerator and Freezer Service and Repair
Unit 4

Job Sheet 9—Repair a Leak in an Aluminum Evaporator Using a Pre-mixed Two-Part Epoxy Stick

Name ______________________________ Attempt Number ____________

Date ______________________________ Overall Rating ____________

Evaluation Criteria	**Rating**
Patch area properly prepared	______
Nitrogen circulated during repair	______
Epoxy stick properly prepared and applied	______
System pressurized and leak checked	______
Drier replaced, system evacuated and charged	______
Operating pressures and temperatures recorded	______

A. Tools and materials

Small refrigerated appliance w/aluminum evaporator
Refrigeration technician's hand tools w/utility knife
Vacuum pump
Manifold gauge set
Refrigerant recovery equipment
Dry nitrogen cylinder w/regulator
Torch assembly
Heat shield(s) and/or heat block
Leak detector
Filter-drier to system specifications
Fine grade sand cloth or stainless steel brush
Pre-mixed two-part epoxy stick (La-Co Heat Seal Stick® or equivalent)
Shop towels
Gloves (optional)
Safety glasses

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Locate the specific point where the leak is located on the evaporator coil.

Note: This may entail pressurizing and leak checking.

☐ 3. Recover any refrigerant that remains in the system, or release the pressure left from leak checking.

☐ 4. Use a stainless steel brush, sand cloth, and a shop towel to thoroughly clean the surface around the leak at least 1/2 inch away from the leak.

Job Sheet 9

☐ 5. Rough up the aluminum surface lightly with a stainless steel brush so that the epoxy will have a good bonding surface.

☐ 6. Attach gauge set and vacuum pump.

☐ 7. Pull 2 to 4 inches of vacuum on the system.

☐ 8. Use a fresh epoxy stick or the clean end of a preused stick and trim it to fit the surface of the patch area.

Note: Hold the stick lightly between your thumb and forefinger to avoid too much downward pressure; if you hold the stick like you hold a pencil, you may have a tendency to press down too hard.

☐ 9. Put heat shield(s) or heat block in place as required.

☐ 10. Put on colored safety glasses, and use the torch to lightly heat the area around the leak, but do not put the flame directly on the patch area or on the epoxy stick.

Note: Remember that this is not a brazing process; you want gentle, controlled heat.

☐ 11. Lightly touch the stick to the surface of the patch area with a circular motion.

☐ 12. As the epoxy begins to melt, continue with a light circular and crisis-cross pattern to place the epoxy around and over the patch area.

☐ 13. Be careful not to push the material into the hole so that it may plug the line; the stick should move smoothly as the epoxy melts onto the patch area, creating a thin coating.

☐ 14. Bounce the flame lightly on each side of the patch area to keep the area properly heated.

☐ 15. After you get the patch area thoroughly coated with epoxy, feather or tickle the surface in a circular pattern with the tip of the torch flame.

☐ 16. When the material on the patch area begins to smooth out and change from the color of the epoxy stick to an olive drab green, take the torch away and allow the patch to cool naturally to ambient temperature.

Note: If the epoxy over the patch area starts bubbling or turning black, stop, let the area cool, reclean, and start over.

☐ 17. If the epoxy patch layer is not thick enough or is not in the right location, repeat steps required to put another epoxy layer over the first one.

Note: Be extremely careful to prevent overheating the first layer.

☐ 18. Pressurize and leak check.

Job Sheet 9

☐ 19. If patch area leaks, clean the patch area and repeat the procedure.

☐ 20. If patch area does not leak, replace the liquid line drier, and then evacuate and charge the system.

Note: Refer to Job Sheets 12, 13, and 14 as needed.

☐ 21. Record temperatures and pressures on the service work order that accompanies this job sheet.

☐ 22. Have your instructor check your results.

☐ 23. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

Job Sheet 9

Service Work Order

Customer's Name ______________________________

Customer's Address ______________________________

Brief description of problem ______________________________

____

____

Time and date service or repair started ______________________________

Time and date service or repair ended ______________________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ______________________________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ______________________________

What amount of refrigerant was added? ______________________________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type?__________ Amount? _______

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ______________________________ Date ______________

Job Sheet 9

Service Work Order

Evaluation of unit condition and general performance:

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
e. Liquid line pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
f. Evaporator temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
g. Other compartment temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
h. Condenser air temperatures at end of cycle	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
i. Additional information			
j. Additional information			

k. Technician signature ______________________ Date ____________

Refrigerator and Freezer Service and Repair
Unit 4

Job Sheet 10—Repair a Hole in an Aluminum Evaporator by Brazing

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	Rating
System properly prepared for service	______
Original liquid line drier removed	______
Patch area properly prepared	______
Brazing rod and flux properly applied	______
Heat shield(s) used as needed	______
Patch properly cleaned	______
System pressurized and leak checked	______
Operating pressures and temperatures recorded	______

A. Tools and materials

Small refrigerated appliance w/coil-type aluminum evaporator
Refrigeration technician's hand tools
Vacuum pump
Manifold gauge set
Refrigerant recovery equipment
Dry nitrogen cylinder w/regulator
Torch assembly
Heat shield(s) and/or heat block
Leak detector
Filter-drier to system specifications
Fine grade sand cloth or stainless steel brush
Aluminum brazing kit
Shop towels
Gloves (optional)
Safety glasses and colored safety glasses

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Locate the specific point where the leak is located on the evaporator coil.

Note: This may entail pressurizing and leak checking.

☐ 3. Recover any refrigerant that remains in the system, or release the pressure left from leak checking.

☐ 4. Disassemble as necessary to permit access to the point needing repair.

Job Sheet 10

☐ 5. Use a stainless steel brush, sand cloth, and a shop towel to thoroughly clean the surface around the leak at least 1/2 inch away from the leak.

Note: You may need to tilt the evaporator away from the point of repair so oil will not run out of the hole during repair.

☐ 6. Place heat shield(s) or heat block as needed.

☐ 7. Put on colored safety glasses, and light the torch.

☐ 8. Warm one end of the brazing rod and dip it into the powdered flux.

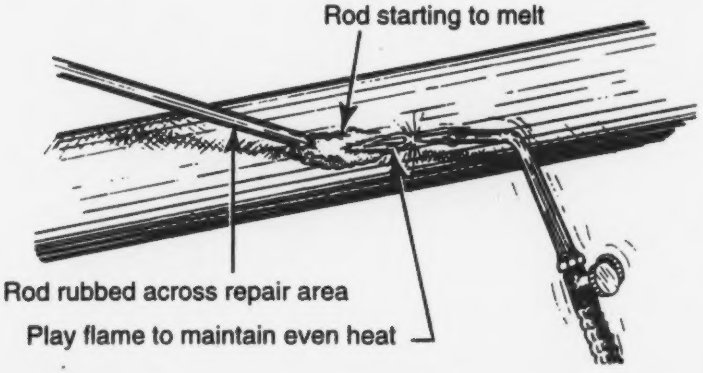
☐ 9. Melt flux off of the brazing rod onto the area around the hole.

☐ 10. Keep the torch in motion and heat the patch area until the flux turns to a glistening liquid and appears to flow into the metal.

Note: Aluminum is easy to overheat and does not change color when it is heated, so be cautious and keep the torch moving.

☐ 11. Melt the brazing rod onto the flux area around the leak while keeping the flame on the fluxed area.

☐ 12. Rub the brazing rod over the entire patch area as the rod begins to melt.


Rod starting to melt
Rod rubbed across repair area
Play flame to maintain even heat

☐ 13. Keep the torch in motion until the melted rod appears to vanish into the flux and cover the hole.

☐ 14. Shut the torch down and permit the area to cool.

☐ 15. Remove flux residue with water and a clean shop towel.

☐ 16. Pressurize and leak check.

☐ 17. If patch area leaks, clean the patch area and repeat the procedure.

Job Sheet 10

☐ 18. If patch area does not leak, replace the liquid line drier, and then evacuate and charge the system.

Note: Refer to Job Sheets 12, 13, and 14 as needed.

☐ 19. Start the system.

☐ 20. Record temperatures and pressures on the service work order that accompanies this job sheet.

☐ 21. Have your instructor check your results.

☐ 22. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

____

____

ACRD-169

Job Sheet 10

Service Work Order

Customer's Name ______________________________

Customer's Address ______________________________

Brief description of problem ______________________________

____

____

Time and date service or repair started ______________________________

Time and date service or repair ended ______________________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ______________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ______________

What amount of refrigerant was added? ______________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type?________ Amount? ______

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ______________________ Date ______________

Job Sheet 10

Service Work Order

Evaluation of unit condition and general performance:

____

____

____

____

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
e. Liquid line pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
f. Evaporator temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
g. Other compartment temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
h. Condenser air temperatures at end of cycle	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
i. Additional information			
j. Additional information			
k. Technician signature ____________________ Date __________			

Refrigerator and Freezer Service and Repair
Unit 4

Job Sheet 11—Make an Aluminum-to-Aluminum or an Aluminum-to-Copper Swage Joint

Name ____________________ Attempt Number ____________

Date ____________________ Overall Rating ____________

Evaluation Criteria	Rating
System properly prepared for service	______
Liquid line drier removed	______
Mating surfaces properly prepared	______
Brazing rod and flux properly applied	______
Heat shield(s) used as needed	______
Swage properly cleaned	______
Drier replaced; system pressurized and leak checked	______
Operating temperatures and pressures recorded	______

A. Tools and materials

Small refrigerated appliance w/coil-type evaporator
Refrigeration technician's hand tools
Vacuum pump
Manifold gauge set
Refrigerant recovery equipment
Dry nitrogen cylinder w/regulator
Torch assembly
Heat shield(s) and/or heat block
Leak detector
Filter-drier to system specifications
Find grade sand cloth or stainless steel brush
Aluminum solder and aluminum flux (or a kit)
Shop towels
Safety glasses and colored safety glasses

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Disassemble the appliance as necessary to permit access to the point or swage joint your instructor identifies as needing repair.

☐ 3. Recover any refrigerant that remains in the system, or release the pressure left from leak checking.

☐ 4. Cut the tubing on each side of the point or swage joint to be repaired.

Job Sheet 11

☐ 5. Swage one tubing end according to the following:

  a. If the connection is an aluminum-to-copper joint, swage the copper so the heat applied to the copper will be transferred to the aluminum and reduce the risk of overheating the aluminum.

  b. If the connection is an aluminum-to-aluminum joint, swage the tubing end that has the open end facing you so you will be able to see into the joint while soldering.

  c. If the connection is an aluminum-to-aluminum joint, and you can easily see into either end, swage the end that is receiving the flow.

☐ 6. Use a stainless steel brush or sand cloth to clean the swage socket and mating end.

☐ 7. As a final step in cleaning aluminum mating surfaces, rough up the surface with a stainless steel brush.

Note: You may need to tilt the evaporator away from the point of repair so oil will not run out during repair.

☐ 8. Apply a small amount of flux to the male aluminum end because in all cases the male end will be aluminum.

☐ 9. Insert the tubing into the swage socket and twist the tubing, if possible, to spread the flux.

☐ 10. Use heat shield or heat block as required to protect components adjacent to the work area.

☐ 11. Put on colored safety glasses.

☐ 12. Light the torch and adjust it to as soft a flame as possible.

☐ 13. Dip one end of the solder into the flux.

☐ 14. Start moving the torch in a slow, circular motion to heat the swage and the tubing without allowing the flame to touch the flux area.

☐ 15. Concentrate the heat on the socket side of the joint after the joint becomes heated.

☐ 16. Touch the solder to the heated joint until it begins to flow into the joint.

☐ 17. Dip the end of the solder into the flux from time to time and continue to touch the solder to the heated joint until solder flows into the joint all the way around.

☐ 18. Turn off the torch and allow the joint to cool.

☐ 19. Use a damp shop cloth to clean the joint.

Job Sheet 11

☐ 20. Have your instructor check your work.

☐ 21. Pressurize and leak check.

☐ 22. If joint leaks, repeat the soldering process, or cut the joint out and start over.

☐ 23. If joint does not leak, replace the liquid-line drier, evacuate, and charge the system.

Note: Refer to Job Sheets 12, 13, and 14 as needed.

☐ 24. Start the system after instructor approves your work.

☐ 25. Record temperatures and pressures on the service work order that accompanies this job sheet.

☐ 26. Have your instructor check your results.

☐ 27. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ____________________

____

____

Job Sheet 11

Service Work Order

Customer's Name ______________________________

Customer's Address ______________________________

Brief description of problem ______________________________

____

____

Time and date service or repair started ______________________________

Time and date service or repair ended ______________________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ______________________________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ______________________________

What amount of refrigerant was added? ______________________________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type? ________ Amount? ______

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ______________________________ Date ______________

Job Sheet 11

Service Work Order

Evaluation of unit condition and general performance:

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
e. Liquid line pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
f. Evaporator temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
g. Other compartment temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
h. Condenser air temperatures at end of cycle	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
i. Additional information			
j. Additional information			

k. Technician signature ______________________ Date ____________

Refrigerator and Freezer Service and Repair
Unit 4

Job Sheet 12—Replace a Liquid Line Filter-Drier

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
Nitrogen circulated through system	______
Original Drier properly removed	______
Mating ends of tubing properly cleaned	______
New drier properly brazed into place	______
New drier properly oriented with flow	______

A. Tools and materials

Appliance as selected by instructor
Torch assembly
Heat shield(s) and/or heat block
Safety glasses and colored safety glasses
Sweat-type filter drier
Brazing rod
Flux, if needed
Sand cloth and/or wire brushes
Shop towels
Component protective shields such as pieces of sheet metal shaped as needed
Heat shield or heat block
Nitrogen cylinder w/regulator
Refrigeration technician's hand tools

B. Procedure

> **Special Note**
>
> This procedure is always performed as the last part of the assembly process. It assumes that refrigerant has been removed from the system and that the manifold gauge set is still attached to the system.

☐ 1. Put on colored safety glasses.

☐ 2. Attach the nitrogen cylinder to the low side of the system.

Job Sheet 12

☐ 3. Set nitrogen regulator for 2 to 4 psig.

☐ 4. Allow nitrogen to circulate through the system.

☐ 5. Check nearby components and set up heat shields as required, and handle the torch safely in order to protect system components as you finish this activity.

☐ 6. Use the torch to heat up the end of the drier which has the capillary tube brazed into it while holding the cap tube with pliers.

☐ 7. When the brazing alloy liquifies, pull the cap tube out of the drier.

☐ 8. Use the torch to heat up the other end of the drier while holding the drier with the pliers.

☐ 9. When the brazing alloy liquifies, pull the drier off of the liquid line and place it in a safe place until it cools enough to safely handle before you dispose of it.

☐ 10. After lines cool sufficiently for handling, clean the end of the liquid line with sand cloth.

☐ 11. Clean the end of the cap tube from a point approximately 1 inch from the end to a point 2 inches from the end with sand cloth.

☐ 12. If the connecting ends show signs of not being thoroughly clean, apply silver brazing flux to the liquid line end and the cap tube end.

☐ 13. Remove the inlet end of the replacement drier; this may be a protective cap, an end which must be cut off, or an end which may be snapped off.

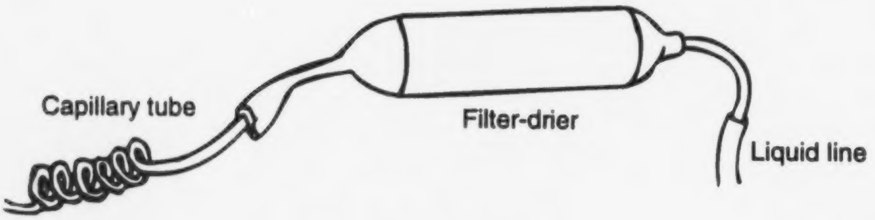
Note: Direction of flow is usually indicated by an arrow or other markings on the drier while some driers may be installed in either direction.

☐ 14. Twist the drier while placing it onto the liquid line.

Job Sheet 12

☐ 15. Insert the full 2-inch end of the cap tube into the outlet of the drier while making sure that the end does not hit against anything that might block the cap tube opening.

☐ 16. Pinch the tubing at the end of the drier to fit the cap tube.



☐ 17. Put on colored safety glasses, put heat shield(s) or component protective shields in place, and light the torch.

☐ 18. Braze both ends.

☐ 19. If flux was used, clean both joints with a damp cloth.

☐ 20. Continue with other procedure as needed or pressurize and leak check the system.

☐ 21. Have your instructor check your work.

☐ 22. Clean up area and return tools and materials no longer needed to proper storage or prepare for next job sheet as directed by your instructor.

Evaluator's Comments: ______________________________

____

____

Job Sheet 12

Service Work Order

Customer's Name ____________________

Customer's Address ____________________

Brief description of problem ____________________

____

____

Time and date service or repair started ____________________

Time and date service or repair ended ____________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No
If refrigerant was removed, what was the disposition of the refrigerant removed?
☐ Recovered on site and returned in total to the system at end of service.
☐ Recycled on site and returned in total to the system at end of service.
☐ Retained in approved recovery cylinder for future disposition.
If refrigerant was recovered and retained, include type and weight ____________________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No
If refrigerant was added, what refrigerant was used? ____________________
What amount of refrigerant was added? ____________________
Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No
Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type?________ Amount? ______

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No
Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ____________________ Date ____________

Job Sheet 12

Service Work Order

Evaluation of unit condition and general performance:

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
e. Liquid line pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
f. Evaporator temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
g. Other compartment temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
h. Condenser air temperatures at end of cycle	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
i. Additional information			
j. Additional information			

k. Technician signature ______________________ Date ____________

Refrigerator and Freezer Service and Repair
Unit 4

Job Sheet 13—Charge a Small Refrigerated Appliance Using a Charging Cylinder

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
Refrigerant type and amount properly selected	______
Charging cylinder safely warmed	______
Cylinder oriented for liquid line charging	______
Cylinder oriented for low side charging	______
Operating pressures/temperatures recorded	______

A. Tools and materials

Appliance as selected by instructor
HCFC or CFC refrigerant per system specifications
Charging cylinder calibrated for selected refrigerant
Manufacturer's operating conditions chart or equivalent
Thermometers
Safety glasses
Shop towels
Refrigeration technician's hand tools

B. Procedure

☐ 1. Put on safety glasses.

Special Note

This procedure is always performed as the last part of the assembly process. It assumes that refrigerant has been removed from the system and that the manifold gauge set is still attached to the system. Your instructor may have you repeat this procedure using HFC 134a.

☐ 2. Check manufacturer's literature or data plate to determine the type and amount of refrigerant charge the system requires.

Job Sheet 13

☐ 3. Fill the charging cylinder with the proper type and amount of refrigerant.

Note: Be sure the dial on the charging cylinder is set to the proper refrigerant and pressure reading, and that it has been properly emptied.

☐ 4. If charging cylinder has a built-in heater, plug it in and allow temperature and pressure to build up.

☐ 5. If charging cylinder does not have a built-in heater, another heat source such as a drop light, heat gun, or a blow dryer may be used to raise the temperature and pressure of the refrigerant.

Caution: Never apply a flame or excessive heat to a cylinder that has refrigerant in it!

☐ 6. Introduce refrigerant into the system through the liquid line if access is available.

☐ 7. When charging through the liquid line, hook the bottom valve of the charging cylinder to the system.

☐ 8. When charging through the low side, hook the top valve of the charging cylinder to the system.

☐ 9. Open the charging cylinder valve and purge the charging hose connecting the charging cylinder to the manifold gauge set.

☐ 10. When charging cylinder pressure reaches approximately 150 psig, open the appropriate side of the manifold gauge set and allow the refrigerant to enter the system.

☐ 11. Approximately 15 seconds after liquid is no longer visible in the charging cylinder, discontinue application of heat, and close the cylinder valve.

☐ 12. Have your instructor check your work.

☐ 13. When charging through the low side, start the system after approximately three-fourths of the charge has entered the system.

☐ 14. If the charging cylinder does not have a heater and access is available to both the low side of the system and the liquid line, add refrigerant as a liquid until system and cylinder pressures equalize, start the system, and then finish charging through the low side; this is a simple, but effective time saver.

Caution: Never attempt to add refrigerant through the high side of a system when the compressor is running.

Job Sheet 13

☐ 15. Disconnect the charging cylinder, and start the system, if you have not already started it.

☐ 16. Record pressures and temperatures on your service work order that accompanies this job sheet, and compare them to the manufacturer's operating conditions chart or a typical operating conditions chart.

☐ 17. Have your instructor check your results.

☐ 18. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

____

____

Job Sheet 13

Service Work Order

Customer's Name ______________________________

Customer's Address ______________________________

Brief description of problem ______________________________

____

____

Time and date service or repair started ______________________________

Time and date service or repair ended ______________________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ______________________________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ______________________________

What amount of refrigerant was added? ______________________________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type?__________ Amount? __________

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ______________________________ Date ______________

Job Sheet 13

Service Work Order

Evaluation of unit condition and general performance:

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
e. Liquid line pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
f. Evaporator temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
g. Other compartment temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
h. Condenser air temperatures at end of cycle	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
i. Additional information			
j. Additional information			

k. Technician signature ______________________ Date ______________

Refrigerator and Freezer Service and Repair
Unit 4

Job Sheet 14—Charge a Small Refrigerated Appliance Using Charging Scales

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
Scales properly set up	______
Refrigerant charge properly measured	______
Cylinder upright or inverted as required	______
Operating temperature and pressures recorded	______

A. Tools and materials

Appliance as selected by instructor
HCFC or CFC refrigerant per system specifications
Charging scales
Manufacturer's operating conditions chart or equivalent
Thermometers
Safety glasses
Shop towels
Extra charging hose
Refrigeration technician's hand tools

B. Procedure

☐ 1. Put on safety glasses.

Special Note

This procedure is always performed as the last part of the assembly process. It assumes that refrigerant has been removed from the system and that the manifold gauge set is still attached to the system.

☐ 2. Check manufacturer's literature or data plate to determine the type and amount of refrigerant charge the system requires.

☐ 3. When using automatic charging scales which have a built-in valve, attach the center gauge hose to the outlet port on the scales, and a separate hose to the refrigerant cylinder and the inlet port on the scales.

Job Sheet 14

☐ 4. When using charging scales which do not have a built-in valve, attach the center gauge hose directly to the refrigerant cylinder.

☐ 5. Open refrigerant cylinder valve and purge the hose connected to it.

☐ 6. When using automatic scales, program the scales to open the valve on the scale, and purge the hose from the outlet to the center of the gauge set.

☐ 7. Reset the scales to close the outlet port.

☐ 8. When charging through the liquid line, invert the refrigerant cylinder on the scales.

☐ 9. When charging through the low side, place the refrigerant cylinder upright on the scales.

☐ 10. Program scales for the specified amount of refrigerant charge, or zero the scales if they are not automatic.

☐ 11. If the scales are automatic, switch the scales to the charge setting.

☐ 12. Open appropriate gauge set valve and allow refrigerant to enter the system.

☐ 13. If scales are not automatic, shut valve when scales indicate the specified amount of refrigerant has entered the system.

☐ 14. If the system pressures equalize with the refrigerant cylinder before the specified amount of refrigerant has entered the system, check with your instructor first, then start the system and complete charging through the low side, if access is available.

☐ 15. If low side access is not available, the scales and cylinder will have to be elevated above the system so gravity will make the refrigerant flow into the system after pressures have equalized.

Caution: Never attempt to add refrigerant through the high side of a system when the compressor is running.

☐ 16. Have your instructor check your work.

☐ 17. Start the system, if you have not already started it, and disconnect refrigerant cylinder and scales.

☐ 18. Record pressures and temperatures on your service work order that accompanies this job sheet, and compare them to the manufacturer's operating conditions chart or a typical operating conditions chart.

Job Sheet 14

☐ 19. Have your instructor check your results.

☐ 20. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

ACRD-193

Job Sheet 14

Service Work Order

Customer's Name ______________________________

Customer's Address ______________________________

Brief description of problem ______________________________

____

____

Time and date service or repair started ______________________________

Time and date service or repair ended ______________________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No
If refrigerant was removed, what was the disposition of the refrigerant removed?
☐ Recovered on site and returned in total to the system at end of service.
☐ Recycled on site and returned in total to the system at end of service.
☐ Retained in approved recovery cylinder for future disposition.
If refrigerant was recovered and retained, include type and weight ______________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No
If refrigerant was added, what refrigerant was used? ______________
What amount of refrigerant was added? ______________
Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No
Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type? ________ Amount? ______

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No
Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ______________ Date ______________

Job Sheet 14

Service Work Order

Evaluation of unit condition and general performance:

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
e. Liquid line pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
f. Evaporator temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
g. Other compartment temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
h. Condenser air temperatures at end of cycle	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
i. Additional information			
j. Additional information			
k. Technician signature ____________ Date ________			

Refrigerator and Freezer Service and Repair
Unit 4

Job Sheet 15—Service a Capillary Tube

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	Rating
System properly prepared for service	______
Original liquid line drier removed	______
Cap tube prepared and tested	______
Nitrogen circulated thru system during service	______
Cap tube replaced and brazed as required	______
Drier replaced; system pressurized and leak checked	______
Operating temperatures and pressures recorded	______

A. Tools and materials

Small refrigerated appliance w/restricted capillary tube
Refrigeration technician's hand tools
Tubing cutter
Torch assembly
Heat shield(s) and/or heat block
Component protective shields such as pieces of sheet metal shaped as needed
Cap tube cleaner
Slim taper file
Slide caliper
Capillary tube gauge or orifice drill set
Manifold gauge set
Refrigerant recovery equipment
Dry nitrogen cylinder w/regulator
Leak detector
Assorted sizes of capillary tubing
Brazing alloy and flux
50/50 soft solder or equivalent
Filter-drier to system specifications

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Disconnect appliance from electrical power.

☐ 3. Recover refrigerant and leave the gauge set attached to the low side.

☐ 4. Remove the liquid line drier per the procedure in Job Sheet 12.

Job Sheet 15

☐ 5. Clean the end of the cap tube that you removed from the drier.

☐ 6. Attach dry nitrogen cylinder to the center hose of the gauge set.

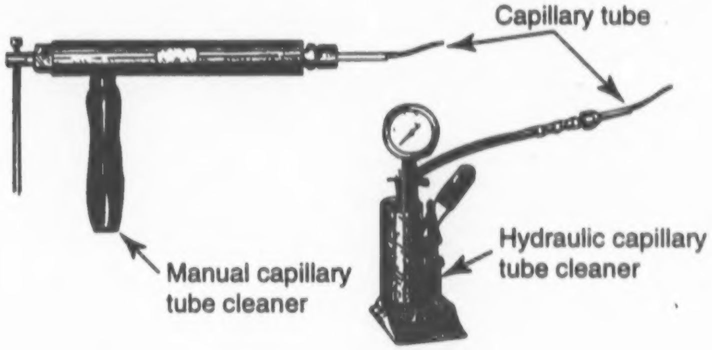
☐ 7. Set nitrogen regulator for 150 psig, or the maximum test pressure shown on the data plate, and while blocking the open end of the liquid line with a shop cloth, allow nitrogen to flow through the system.

Note: If the restriction is at the entrance to the cap tube, the nitrogen pressure may blow what is causing the restriction out of the system.

☐ 8. If nitrogen seems to be flowing freely from the end of the cap tube, proceed to Step 16.

☐ 9. If nitrogen does not seem to be flowing freely, check with your instructor before continuing.

☐ 10. If cap tube is still restricted, use a cap tube cleaner according to cleaner manufacturer's instructions to clean out the cap tube.


Capillary tube
Manual capillary tube cleaner
Hydraulic capillary tube cleaner

☐ 11. Repeat Steps 7 and 8.

☐ 12. If cap tube is still restricted, cut approximately 6 inches from the end of the cap tube.

Note: Remember, the best procedure for cutting capillary tubing is to score it with a slim taper file and break it off so the inside diameter of the tubing will not be reduced.

☐ 13. Repeat Step 7.

☐ 14. If the cap tube is still restricted, the entire capillary tube will have to be replaced, and this means it is probably less expensive to replace the appliance.

Note: Installing a new capillary tube is expensive because it is labor intensive and often requires special procedures.

Job Sheet 15

☐ 15, If cap tube is no longer restricted, the obstruction is in the 6-inch piece you removed, so replace the piece with the following routine:

a. Measure the inside and outside diameters of the capillary tubing with calipers and a capillary tube gauge or an orifice drill set.

b. Select new capillary tubing of the same size, and cut off exactly the same amount of tubing that you removed from the appliance.

Note: A different size cap tube may be used if the length is adjusted. See your instructor for procedure.

c. Cut a 4-inch piece of tubing with an inside diameter the size of the outside diameter of the capillary tube or slightly larger.

d. Check to make sure that the end of the original cap tube in the appliance and both ends of the replacement tubing are not restricted in any way.

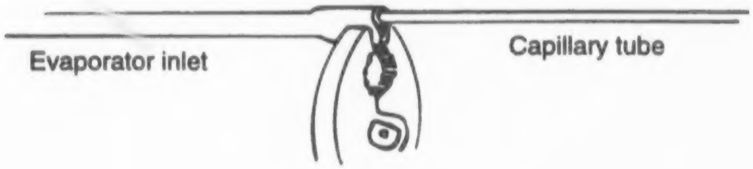
e. Pick a spot on the replacement piece of capillary tubing 1 inch from one end and then clean 1 1/2 inches of the tubing from that spot.

f. Repeat the procedure in item (e) with the end of the original cap tube.

g. Clean the inside of the 4-inch piece of tubing.

h. Insert the two cleaned ends of capillary tubing into the 4-inch piece so that the ends of the capillary tubing meet in the middle of the 4-inch piece.

i. Use pliers to pinch the 4-inch piece into place along the capillary tubing.



j. Braze both ends in place.

Note: Be sure heat shield(s), heat block, or component shield(s) is in place before brazing.

k. Proceed to Step 16.

☐ 16. Replace the liquid line drier.

Job Sheet 15

☐ 17. Leak test, evacuate, and charge the system with the specified amount of refrigerant.

Note: Reference Job Sheets 12, 13, and 14 as needed.

☐ 18. Have your instructor check your installation.

☐ 19. Start system and record temperatures and pressures on the chart in the service work order that accompanies this job sheet.

☐ 20. Have your instructor check your results.

☐ 21. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

____

____

Job Sheet 15

Service Work Order

Customer's Name ______________________________

Customer's Address ______________________________

Brief description of problem ______________________________

____

____

Time and date service or repair started ______________________________

Time and date service or repair ended ______________________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ______________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ______________

What amount of refrigerant was added? ______________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type? ________ Amount? ______

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ______________ Date ______________

Job Sheet 15

Service Work Order

Evaluation of unit condition and general performance:

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
e. Liquid line pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
f. Evaporator temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
g. Other compartment temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
h. Condenser air temperatures at end of cycle	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
i. Additional information			
j. Additional information			
k. Technician signature ______ Date ______			

Refrigerator and Freezer Service and Repair
Unit 4

Job Sheet 16—Replace a Compressor

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	Rating
Original compressor condition verified	______
Acid test kit used to check for burnout	______
System flushed with dry nitrogen	______
Replacement compressor brazed into place	______
Liquid line drier replaced	______
Suction line drier replaced (as required)	______
System pressurized and leak checked	______
Operating temperatures and pressures recorded	______

A. Tools and materials

Small refrigerated appliance
Replacement compressor
Refrigeration technician's hand tools
Tubing cutter
Torch assembly
Heat shield(s) or heat block
Component protective shields such as pieces of sheet metal shaped as needed
Manifold gauge set
Refrigerant recovery equipment
Refrigerant to specifications
Dry nitrogen cylinder w/regulator
Leak detector
Brazing alloy and flux
Filter-drier to system specifications

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Check the appliance compressor to be sure that the original diagnosis of a faulty compressor is correct, even if the appliance is accompanied by written verification.

Note: If you replace a compressor that does not need to be replaced, the company may have to pay for it, or demand that you pay for it.

☐ 3. Disconnect appliance from electrical power.

☐ 4. Recover refrigerant and leave the gauge set attached to the low side, if possible.

Job Sheet 16

☐ 5. Disconnect electrical connections and components from the compressor, and place them aside so they will not interfere with your work.

☐ 6. Detach or remove any other electrical or cabinet components that might interfere.

☐ 7. Remove the liquid line drier per the procedure in Job Sheet 12.

☐ 8. Disconnect tubing from the compressor by unsweating or cutting the lines.

Note: Because discharge lines are usually made of steel, leave some copper tubing attached to the steel if you can: this will make it easier to braze the line to the new compressor because brazing dissimilar metal is more difficult.

☐ 9. Disconnect compressor mounting and remove the compressor.

☐ 10. If previous electrical checks of the original compressor show open, shorted, or grounded windings, check for burnout.

☐ 11. Smell the original compressor for the distinctive odor of a burnout; you need to sniff the end of the suction stub.

Caution: Be extremely careful when handling the removed compressor; vapor and oil in the compressor may contain acid and other harmful substances.

☐ 12. If conditions in either Step 10 or Step 11 indicate a possible burnout, pour a small amount of oil out of the compressor into a small, clean container.

Caution: Use gloves when handling used compressor oil!

☐ 13. Follow the directions with your acid test kit to test the oil for acid.

☐ 14. Check the inside of the tubing that was connected to the original compressor for discoloration or other signs that will indicate the degree of cleanup that will be required.

Note: This will show you if acidic oil or other contaminants were pushed out into the tubing during burnout.

☐ 15. Remove and clean or replace any tubing, accumulator, or other components with severe contamination.

☐ 16. Connect dry nitrogen to the suction line; this may mean attaching an access valve.

☐ 17. Invert the dry nitrogen cylinder, and allow liquid nitrogen to flow through the system and flush out any contamination.

Job Sheet 16

☐ 18. Right the nitrogen cylinder and disconnect.

☐ 19. Compare original compressor mounting with replacement compressor mounting and the instructions that accompany the new compressor.

☐ 20. Check the replacement compressor to be sure it is the same or the equivalent of the original compressor.

Note: Do not assume you have received the proper compressor; consult a cross-reference guide for selecting a compressor. See Assignment Sheet 4.

☐ 21. Mount the replacement compressor in the appliance.

Note: If the new compressor mounts differently from the original compressor, you may have to reroute some of the tubing before mounting the new compressor.

☐ 22. Place heat shield(s), heat block, or component shields in place as needed.

☐ 23. Connect tubing to the new compressor and braze into place.

Note: In cases of severe burnout, a suction line filter-drier should be added, so make allowances in the suction line for addition of the filter-drier.

☐ 24. Replace the liquid line drier and braze suction line drier into place, if used.

☐ 25. Leak test, evacuate, and charge the system with the specified amount of refrigerant.

Note: Refer to Job Sheets 12, 13, and 14 as needed.

☐ 26. Have your instructor check your installation.

☐ 27. Start system and record temperatures and pressures on the chart in the service work order that accompanies this job sheet.

☐ 28. Have your instructor check your results.

☐ 29. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

____

____

Job Sheet 16

Service Work Order

Customer's Name ____________________

Customer's Address ____________________

Brief description of problem ____________________

____

____

Time and date service or repair started ____________________

Time and date service or repair ended ____________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No
If refrigerant was removed, what was the disposition of the refrigerant removed?
☐ Recovered on site and returned in total to the system at end of service.
☐ Recycled on site and returned in total to the system at end of service.
☐ Retained in approved recovery cylinder for future disposition.
If refrigerant was recovered and retained, include type and weight ____________________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No
If refrigerant was added, what refrigerant was used? ____________________
What amount of refrigerant was added? ____________________
Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No
Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type? __________ Amount? __________

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No
Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ____________________ Date __________

Job Sheet 16

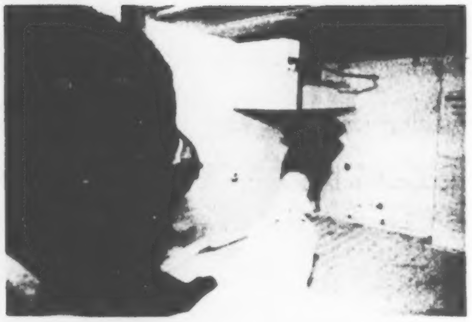
Service Work Order

Evaluation of unit condition and general performance: ____

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
e. Liquid line pressures at start and end of cycle	Start: End:	Start: End:	Start: End:
f. Evaporator temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
g. Other compartment temperatures at start and end of cycle	Start: End:	Start: End:	Start: End:
h. Condenser air temperatures at end of cycle	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
i. Additional information			
j. Additional information			

k. Technician signature ______________________ Date ____________



Domestic Ice Maker Service
Unit 5

Objective Sheet

Unit Objective

After completing this unit, the student should be able to install a refrigerator equipped with an ice maker, clean a water fill valve, replace a thermostat and mold heater in a crescent-shaped cube ice maker, replace the mold, seal, and bearing in a five-cavity ice maker, adjust a water valve on a flex-tray ice maker, and use a troubleshooting guide to identify ice maker problems. The student should demonstrate these competencies by completing the assignment and job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to domestic ice maker service with their correct definitions.
2. Complete statements about basic types of domestic refrigerator ice makers.
3. Complete statements about how a crescent-shaped ice maker works.
4. Complete statements about how a five-cavity ice maker works.
5. Complete statements about how a flex-tray ice maker works.
6. Select true statements about storing and dispensing ice.
7. Select true statements about ice maker water supply and control devices.
8. Identify parts of a crescent-shaped cube ice maker.
9. Identify parts of a five-cavity ice maker.
10. Complete statements about troubleshooting ice makers.
11. Complete statements about ice maker service.
12. Use troubleshooting guides to solve domestic ice maker problems. (Assignment Sheet 1)
13. Install a water line to a refrigerator equipped with an ice maker. (Job Sheet 1)
14. Disassemble and clean a water fill valve. (Job Sheet 2)
15. Replace a thermostat in a crescent-shaped cube ice maker. (Job Sheet 3)

Objective Sheet

16. Replace the mold heater in a crescent-shaped cube ice maker. (Job Sheet 4)
17. Replace the mold, seal, bearing, and retainer in a five-cavity ice maker. (Job Sheet 5)
18. Adjust the water valve switch in a flex-tray ice maker. (Job Sheet 6)

Domestic Ice Maker Service
Unit 5

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction or individual learning activities. Study the specific objectives to determine the order in which you will present the objectives.

2. Review Teaching Suggestions section that follows. Plan for classroom activities.

3. Plan enrichment of exceptional students as well as accommodation of special needs students.

4. Make transparencies from the transparency masters included with this unit. These appear in the teacher edition only and are designed to be used with the following objectives:

   TM 1—Parts of a Crescent-Shaped Cube Ice Maker (Objectives 3 and 8)
   TM 2—Parts of a Five-Cavity Cube Ice Maker (Objectives 4 and 9)

5. Develop teaching plan. Adjust for different learning styles.

6. Make copies of the Unit Evaluation Form.

Delivery and Application

7. Provide students with unit of instruction.

8. Discuss unit and specific objectives.

9. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic skills when applicable.

10. Discuss assignment and job sheets, and demonstrate the job sheets. Review criteria for evaluation of these activities.

Evaluation

11. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.

12. Make copies of the written test. Add or modify test items as needed.

13. Give written test.

14. Compile assignment sheet rating, job sheet ratings, and written test scores on the Unit Evaluation Form. Include any additional assignment or job sheets.

15. Reteach and retest as required.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the Teaching Suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: a SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

1. Have the various types of cube ice makers available as you discuss the beginning objectives of the unit. Point out the advantages and disadvantages of each type and talk with students about the relationship of design to operation, service, and repair. Skill areas: **Thinking skills, seeing things in the mind's eye, science.**

2. Use Objectives 2, 3, and 4 to impress students with the importance of schematics and wiring diagrams in troubleshooting, service, and repair. Skill areas: **Thinking skills, knowing how to learn, science.**

3. Use Objectives 8 and 9 to demonstrate the value of exploded views and illustrated views in ice maker service and repair. Point out the great number of parts a technician may have to work with on a service job, and emphasize the importance of making sketches of how things fit together so you can get them back together in proper order if you don't have an illustration or exploded view to work with. Skill areas: **Thinking skills, learning how to learn, science.**

Resources Used in Developing This Unit

1. Althouse, Andrew D., et al. *Modern Refrigeration and Air Conditioning*. South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.

2. *The Air Conditioning, Heating, and Refrigeration News HVAC/R Source Guide*. Troy, MI: Business News Publishing Company, 1993.

3. Wantiez, Gary W. *Air Conditioning and Refrigeration, Domestic Refrigeration*. Stillwater, OK: The Mid-America Vocational Curriculum Consortium, 1984.

4. Whitman, William C. and William M. Johnson. *Refrigeration & Air Conditioning Technology*, 2nd ed. Albany, NY: Delmar Publishers, Inc., 1991.

Suggested Supplemental Resources

1. Ice maker service manuals are available from Whirlpool for several different models, the crescent-shaped cube ice maker (modular), compact ice makers, and flex-tray ice makers. The manuals cost about $15.00 each. To order, call the Whirlpool Consumer Assistance Center at 1-800-253-1301 and ask for the Parts Department.

2. If the ice maker in a Maytag refrigerator was installed at the Maytag factory, information about the ice maker should be included in a general service manual. Some parts catalogs are also available. For information, call 615-478-6788.

Suggested Activities

3. The Washer Specialities Company of Wichita, Kansas, is an excellent source for ice maker parts. They stock complete add-on ice makers and replacement ice makers for the major ice maker brands. Ice maker repair kits and gear kits are also available along with thermostats and other ice maker controls. If you don't have the latest Armstrong Value Parts Catalog, call for one at 316-263-8179, or write:

   Washer Specialities Co.
   P.O. Box 3268
   224 Indiana Avenue
   Wichita, KS 67201

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

Domestic Ice Maker Service
Unit 5

Answers to Assignment Sheet 1

1. (Order may vary)
   - a. open motor
   - b. open thermostat
   - c. open holding switch
   - d. stuck shut-off valve
2. ejector rod seal is leaking
3. water fill valve switch or connecting wiring open

Domestic Ice Maker Service
Unit 5

Answers to Written Test

1.
   a. 3
   b. 2
   c. 5
   d. 1
   e. 4

2.
   a. Whirlpool
   b. water
   c. Hotpoint
   d. heater
   e. mechanical arm, electrical circuit
   f. twisted, flexed

3.
   a. 2)
   b. 2)
   c. 2)
   d. 2)

4.
   a. freezes
   b. closes
   c. heater
   d. run
   e. rake
   f. water fill
   g. terminated

5.
   a. freezes
   b. gear
   c. continues
   d. twists
   e. releases
   f. revolution
   g. water fill

6. a, c, d, e, f, h, i, k

7. a, c, e

8.
   a. 1
   b. 4
   c. 7
   d. 9
   e. 11
   f. 15
   g. 2
   h. 5
   i. 17
   j. 12
   k. 8
   l. 16
   m. 18
   n. 14
   o. 13
   p. 10
   q. 6
   r. 3

9.
   a. 7
   b. 11
   c. 12
   d. 14
   e. 3
   f. 4
   g. 13
   h. 6
   i. 8
   j. 1
   k. 9
   l. 10
   m. 5
   n. 2

Answers to Written Test

10.
   a.
      1) Water
      2) Electricity, voltage
      3) mechanical parts
   b. happening properly
   c.
      1) water, electricity
      2) cold
      3) control
   d. troubleshooting chart

11.
   a. supply, fill
   b. kitchen sink
   c. main
   d. frequently
   e. replace
   f. easily
   g. special tools
   h. OEM

Domestic Ice Maker Service
Unit 5

Written Test

Name ______________________________ Date ____________ Score ____________

1. Match the terms on the right with their correct definitions.

_______ a. A coating used for bedding ice maker mold heaters into the mold

_______ b. An eccentric rotating shaft which operates another mechanism such as a plunger of the arm on a switch

_______ c. To transfer cube ice into a storage bin

_______ d. Part of the edge of a crescent-shape ice maker mold which prevents the cubes from becoming lodged during harvest

_______ e. The component in most ice makers where ice is shaped and frozen

1. Ice stripper
2. Cam
3. Alumilastic
4. Mold
5. Harvest

2. Complete statements about schematics and pictorials for basic types of domestic refrigerator ice makers. Write in the word(s) that best completes each of the following statements.

a. The crescent shaped cube ice maker is used in several different brands of refrigerators, but the ______________ Corporation holds the patent.

b. Note that the crescent-shaped cube ice maker has a mold heater to assist in releasing cube ice to a collecting bin along with a thermostat and solenoid for ____________ control and a thermostat for motor control.

c. The five-cavity ice maker is made by General Electric for exclusive use with General Electric and ______________ refrigerators.

d. Note that the five-cavity ice maker also uses a mold ______________ to assist in releasing shaped ice to a collecting bin along with thermostats for motor and water control.

e. There are two versions of the flex-tray ice maker, but they both function about the same; one uses a thermostat with a ______________ ______________, and the other uses a thermostat in the ______________ ______________.

f. The flex-tray does not use a mold heater to assist with releasing formed ice; instead, the cube-holding tray is ____________ or ____________ to cause the cube ice to release, and this facet of operation makes it different from the other ice maker types.

Written Test

3. Complete statements about how a crescent-shape ice maker works. Circle the number of the item that best completes each of the following statements.

   a. The most important part of the first revolution of a crescent-shape ice maker is to:

      1) release ice from the mold by activating a mold heater.

      2) prepare the ice maker with the correct amount of water needed to freeze ice cubes.

   b. The first revolution of a crescent-shape ice maker ends when:

      1) a controlled amount of water enters the mold.

      2) the ice rests on the ejector blades, the thermostat is closed, and the timing switch is placed into a normally closed position.

   c. In the second revolution in a crescent-shape ice maker, the shut-off arm raises and lowers the shut-off switch to the normally closed position, and:

      1) the fill valve solenoid opens.

      2) ice is dumped into the storage bin.

   d. The final part of the second revolution in a crescent-shape ice maker is to:

      1) energize the mold heater to assure that all ice has cleared the mold.

      2) energize the water valve solenoid and cause water to enter the mold.

4. Complete statements about how a five-cavity ice maker works. Write in the word(s) that best completes each of the following statements.

   a. Water enters the ice maker mold and ________________.

   b. The ice maker thermostat ________________ at 16°F, and the leaf switch contacts are open during freezing.

   c. The thermostat completes the circuit to the motor and mold heater, and the motor stalls until ice is loosened by the ________________.

   d. The cam rotates to close leaf switch 1 which bypasses the thermostat and the motor will ________________ regardless of the position of the thermostat.

   e. Ice cubes are raised in the mold and swept away by the ________________ assembly as the cam rotates to close leaf switch 2 which energizes the water fill valve solenoid.

   f. Leaf switch 2 opens again after 6 seconds, ending the ________________ ________________ cycle.

   g. The actuator leaf falls into the open area on the cam and the cycle is ________________

Written Test

5. Complete statements about how a flex-tray ice maker works. Write in the word(s) that best completes each of the following statements.

   a. Water enters the ice tray and ________________ .

   b. The ice maker thermostat closes at 15°F, and the thermostat moves a lever arm which actuates a motor switch, and the motor starts turning the ____________ mechanism.

   c. The sensor arm moves down into the ice storage gin; if the gin is full the cycle will stop, and if the bin is not full, the arm returns to its original position and the cycle ________________ .

   d. The cube tray begins to rotate, and at approximately 180°, one corner of the tray hits a stop, but the shaft continues to turn so it ________________ the tray.

   e. The tray stop is detracted which rapidly ________________ the tray from its position and this shakes the cubes into me storage bin.

   f. The tray continues to turn until it completes a 360° ________________ .

   g. The ________________ ________________ switch is energized and deenergized by a cam to start the cycle over again.

6. Select true statements about storing and dispensing ice. Place an "X" beside each true statement.

_______ a. Regardless of whether ice is produced in ice trays or the latest automatic ice maker, most refrigerators provide for storage and/or on-demand dispensing.

_______ b. Storage will always be a container molded to fit in the freezer compartment.

_______ c. Some models permit on-demand dispensing without opening the refrigerator door; this convenience not only appeals to users, it saves energy.

_______ d. On-demand ice dispensing through the refrigerator door is accomplished by a motor driven auger in the ice storage container.

_______ e. The auger is activated by pushing a glass or other container against a lever inset in the front of the appliance.

_______ f. The auger pushes the ice to a hole in the front of the storage container so it can fall through a chute which opens above the activating lever.

_______ g. In all models, the ice maker dumps ice directly into the dispensing container.

_______ h. Some models also dispense cold water at the same location in a similar manner, and other models will dispense whatever soft drink or juice is placed into the dispensing container.

_______ i. A visual check of the components will locate most problems with on-demand dispensers.

_______ j. The auger motor, lever switch, and water fill valve switch are the only electrical components.

_______ k. Check manufacturer's instructions for specifics about the operation of individual models.

7. Select true statements about ice maker water supply and control devices. Place an "X" beside each true statement.

_______ a. The most commonly used source of supply water for an ice maker is the cold water line usually found under the sink in a home and usually adjacent to the area where the refrigerator is installed.

_______ b. The most common way to access supply water is to braze an access valve onto a supply water line.

_______ c. Some saddle valves are self-tapping and simply screw into a supply water line, and other saddle valve types require a technician to drill a hole in the supply line before attaching the saddle valve.

_______ d. The water fill valve operates with a pressure-release mechanism and controls the water supply to an ice maker.

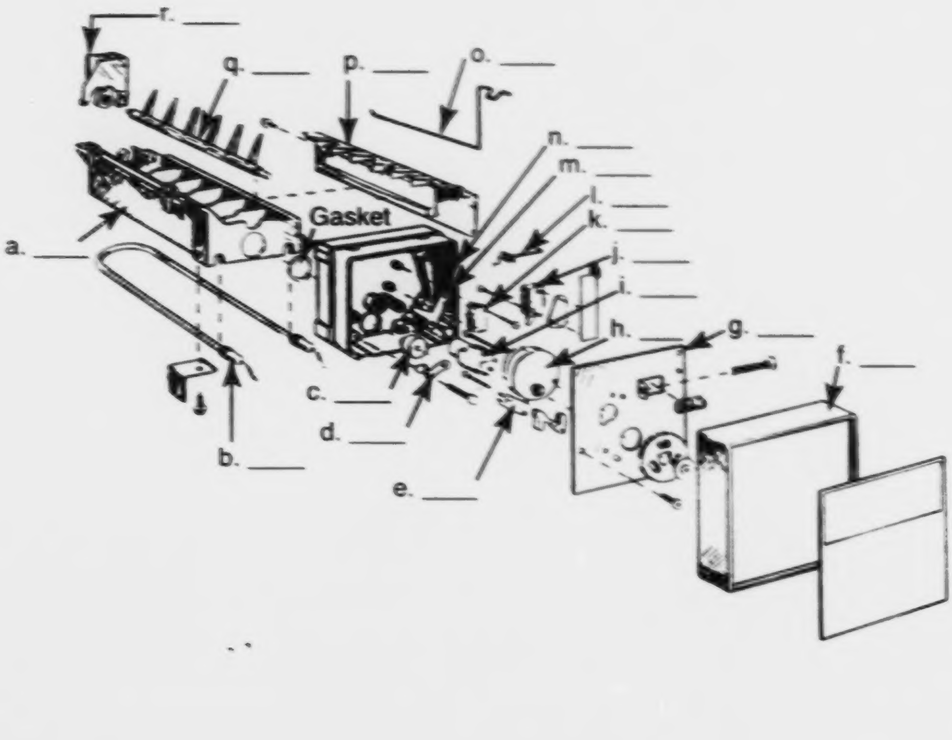
_______ e. The components of a fill valve include a filter screen and flow washer to assure clean water into the valve, and a fill valve body that holds a guide, spring, armature, and diaphragm.

_______ f. Ammonia is often used to clean water fill valve components because it is acidic enough to remove mineral deposits that tend to build up on valve components.

Written Test

8. Identify parts of a crescent-shaped cube ice maker. Place the number beside the part name in the blank beside its illustration.

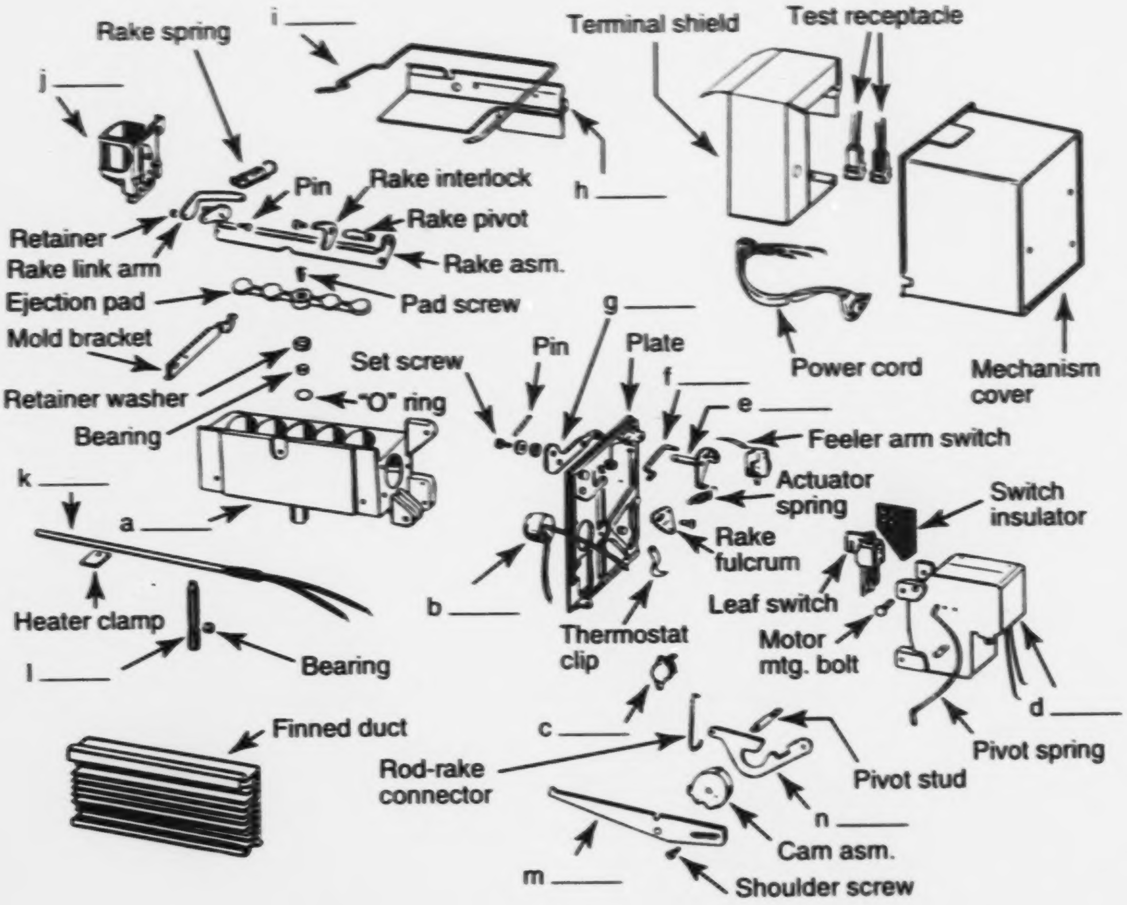
1. Mold
2. Mounting plate
3. Bearing and inlet
4. Mold heater
5. Motor
6. Ejector
7. Thermostat
8. Shut-off switch
9. Thermostat clamp
10. Ice stripper
11. Holding switch
12. Water valve switch
13. Shut-off arm
14. Support
15. Front cover
16. Shut-off arm spring
17. Timing cam
18. Lever arm



Written Test

9. Identify parts of a five-cavity ice maker. Place the number beside the part name in the blank beside its illustration.

   1. Fill cup
   2. Feeler arm and rake lever
   3. Actuator assembly
   4. Actuator rod
   5. Ejector lever arm
   6. Mold shield
   7. Mold assembly
   8. Feeler arm
   9. Mold heater
   10. Ejector rod
   11. Operating thermostat
   12. Safety thermostat
   13. On/off lever
   14. Motor assembly


i _____
Rake spring
j _____
Terminal shield
Test receptacle
Pin
Rake interlock
h _____
Rake pivot
Retainer
Rake link arm
Rake asm.
Ejection pad
Pad screw
Mold bracket
Retainer washer
Bearing
Set screw
"O" ring
g _____
Pin
Plate
Power cord
Mechanism cover
f _____
e _____
Feeler arm switch
k _____
a _____
Actuator spring
Switch insulator
Rake fulcrum
Heater clamp
b _____
Leaf switch
Thermostat clip
Motor mtg. bolt
l _____
Bearing
d _____
Finned duct
c _____
Pivot spring
Rod-rake connector
Pivot stud
n _____
Cam asm.
m _____
Shoulder screw

Written Test

10. Complete statements about troubleshooting ice makers. Insert the word(s) that best completes each of the following statements.

   a. To operate properly, an ice maker must have:

      1) ________________ at the right place and time.

      2) ________________ of the proper ________________ at the right place and time.

      3) properly functioning ________________ ________________ such as gears and levers.

   b. Troubleshooting ice makers usually means identifying which of the items in 10a are not ________________ ________________ and why.

   c. Take the following steps before checking ice maker components for operation:

      1) make sure ________________ and ________________ are available to the ice maker.

      2) make sure the compartment is ________________ enough to trigger the ice making cycle.

      3) make sure switches, feeler arms, or other ________________ mechanisms are in position to call for making ice.

   d. If the qualifications listed in 10c are met, use a ________________ ________________ such as the one in Student Supplement 1 to identify problems with ice maker components.

11. Complete statements about ice maker service. Write in the word(s) that best completes each of the following statements.

   a. Assuring that water is available to an ice maker usually means checking the water ________________ valve and the ice maker water ________________ valve.

   b. The water supply valve is usually a manual valve located under the ________________ ________________, at the hot water tank, or some other accessible location.

   c. Turn off the ________________ water supply to the building before cleaning or replacing an ice maker water supply valve.

   d. Water fill valves ________________ have to be removed, disassembled, and cleaned.

e. While many parts for ice makers are available, it is frequently more economical to ________________ the entire ice maker with a replacement kit designed for a specific application.

f. Most ice makers can be ________________ removed from the refrigerator by unplugging the ice maker from its electrical connection, and loosening or removing a couple of screws.

g. For leaking seals on five-cavity ice makers, there is a special repair kit which requires ________________ ________________.

h. If you have questions about servicing an ice maker, always consult ________________ instructions.

Permission to duplicate this test is granted.

Domestic Ice Maker Service
Unit 5

Unit Evaluation Form

Student Name ______________________________ Unit Rating __________

Assignment Sheet 1—Use Troubleshooting Guides to Solve Domestic Ice Maker Problems Rating ______

Comments:

Job Sheet 1—Install a Water Line to a Refrigerator Equipped With an Ice Maker Rating ______

Comments:

Job Sheet 2—Disassemble and Clean a Water Fill Valve Rating ______

Comments:

Job Sheet 3—Replace a Thermostat in a Crescent-Shaped Cube Ice Maker Rating ______

Comments:

Job Sheet 4—Replace the Mold Heater in a Crescent-Shaped Cube Ice Maker Rating ______

Comments:

Job Sheet 5—Replace the Mold, Seal, Bearing, and Retainer in a Five-Cavity Ice Maker Rating ______

Comments:

Job Sheet 6—Adjust the Water Valve Switch in a Flex-Tray Ice Maker Rating ______

Comments:

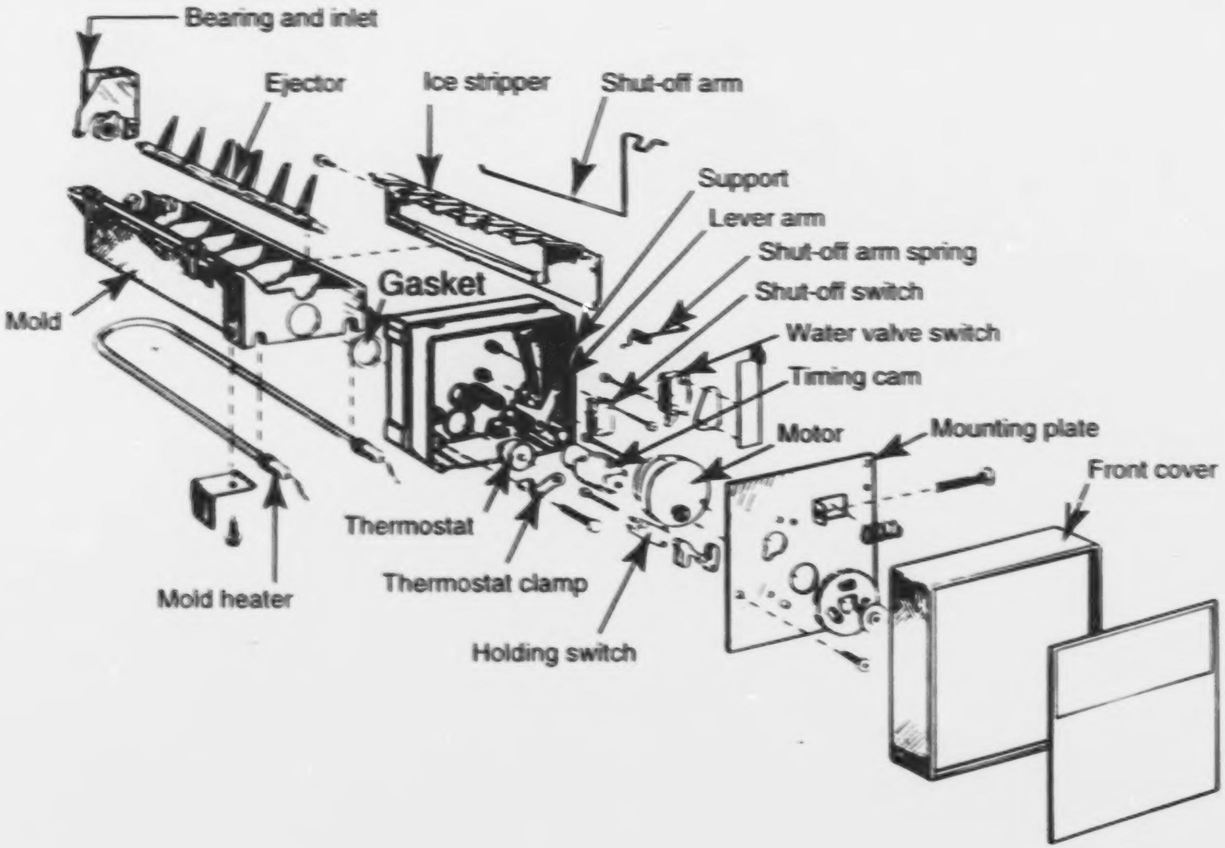
Other:

Unit Evaluation Form

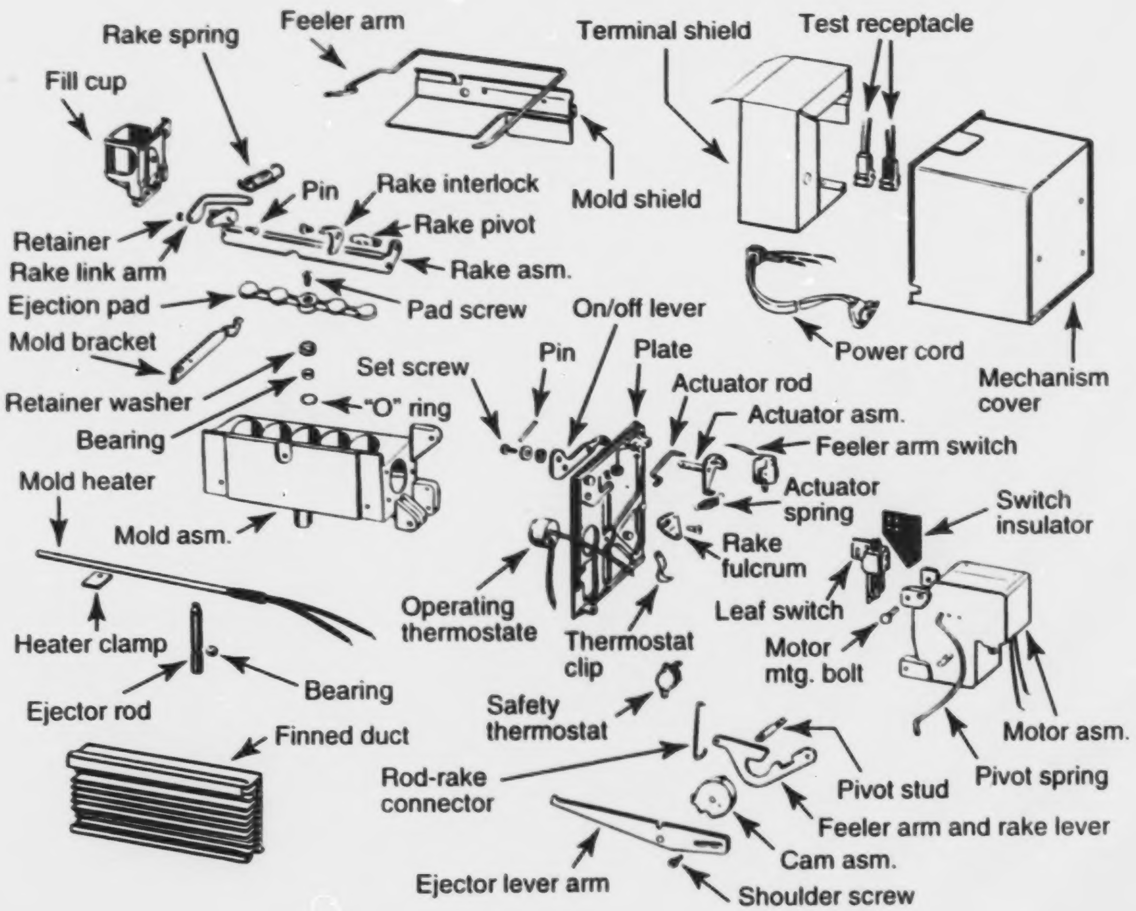
Written Tests: ____________	Pretest ____________	Posttest ____________
		Total ____________
Teacher Signature ______________________________	Date ________________	
Student Signature ______________________________	Date ________________	

Permission to duplicate this form is granted.

Parts of the Crescent Shape Cube Ice Maker


Bearing and inlet
Ejector
Ice stripper
Shut-off arm
Support
Lever arm
Shut-off arm spring
Shut-off switch
Water valve switch
Timing cam
Gasket
Mold
Motor
Mounting plate
Front cover
Thermostat
Thermostat clamp
Holding switch
Mold heater

Parts of the Five Cavity Ice Maker


Rake spring
Feeler arm
Terminal shield
Test receptacle
Fill cup
Pin
Rake interlock
Mold shield
Rake pivot
Retainer
Rake link arm
Rake asm.
Ejection pad
Pad screw
On/off lever
Mold bracket
Pin
Plate
Power cord
Mechanism cover
Set screw
Actuator rod
Retainer washer
"O" ring
Actuator asm.
Bearing
Feeler arm switch
Mold heater
Actuator spring
Switch insulator
Mold asm.
Rake fulcrum
Operating thermostate
Leaf switch
Heater clamp
Thermostat clip
Motor mtg. bolt
Bearing
Ejector rod
Safety thermostat
Motor asm.
Finned duct
Pivot spring
Rod-rake connector
Pivot stud
Feeler arm and rake lever
Cam asm.
Ejector lever arm
Shoulder screw

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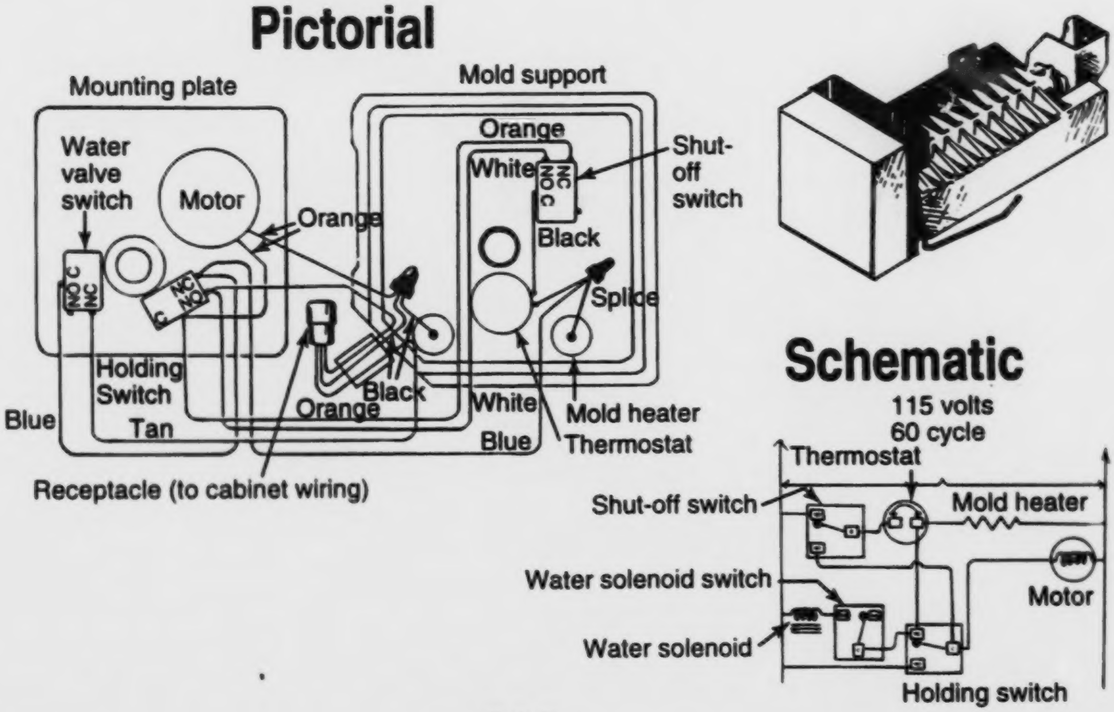
Domestic Ice Maker Service
Unit 5

Information Sheet

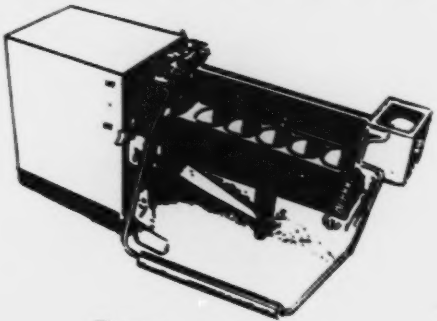
1. **Terms and definitions**
    - a. **Alumilastic**—A coating used for bedding ice maker mold heaters into the mold
    - b. **Cam**—An eccentric rotating shaft which operates another mechanism such as a plunger of the arm on a switch
    - c. **Harvest**—To transfer cube ice into a storage bin
    - d. **Ice stripper**—Part of the edge of a crescent-shape ice maker mold which prevents the cubes from becoming lodged during harvest
    - e. **Mold**—The component where ice is shaped and frozen, in most ice makers
2. **Basic types of domestic refrigerator ice makers**
    - a. The crescent shaped cube ice maker is used in several different brands of refrigerators, but the Whirlpool Corporation holds the patent.
    - b. The crescent-shaped cube ice maker has a mold heater to assist in releasing cube ice to a collecting bin along with a thermostat and solenoid for water control and a thermostat for motor control.


Pictorial
Mounting plate
Mold support
Water valve switch
Motor
Orange
White
NO
NC
C
Shut-off switch
Black
NC
NO
C
Splice
Holding Switch
Black
Orange
White
Mold heater
Blue
Tan
Blue
Thermostat
Receptacle (to cabinet wiring)
Schematic
115 volts
60 cycle
Thermostat
Shut-off switch
Mold heater
Water solenoid switch
Motor
Water solenoid
Holding switch

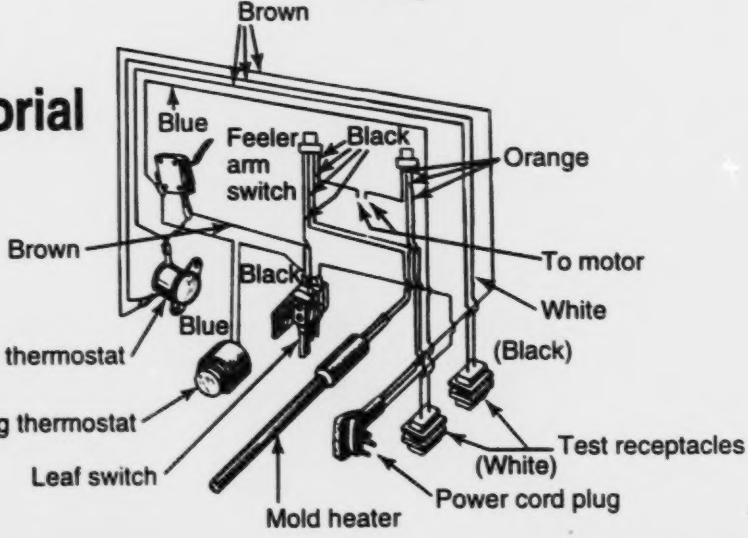
Information Sheet

c. The five-cavity ice maker is made by General Electric for exclusive use with General Electric and Hotpoint refrigerators.

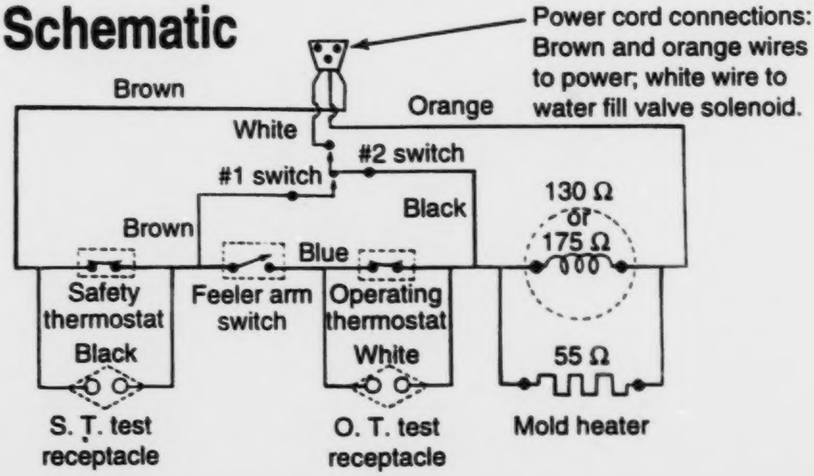
d. The five-cavity ice maker also uses a mold heater to assist in releasing shaped ice to a collecting bin along with thermostats for motor and water control.



Pictorial


Brown
Blue
Feeler arm switch
Black
Orange
Brown
To motor
Black
White
Blue
(Black)
Safety thermostat
Operating thermostat
Test receptacles
(White)
Leaf switch
Power cord plug
Mold heater

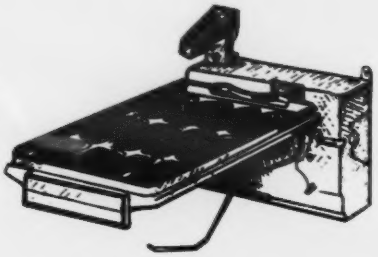
Schematic


Power cord connections: Brown and orange wires to power; white wire to water fill valve solenoid.
Brown
Orange
White
#2 switch
#1 switch
Black
130 Ω
or
175 Ω
Brown
Blue
Safety thermostat
Feeler arm switch
Operating thermostat
Black
White
55 Ω
S. T. test receptacle
O. T. test receptacle
Mold heater

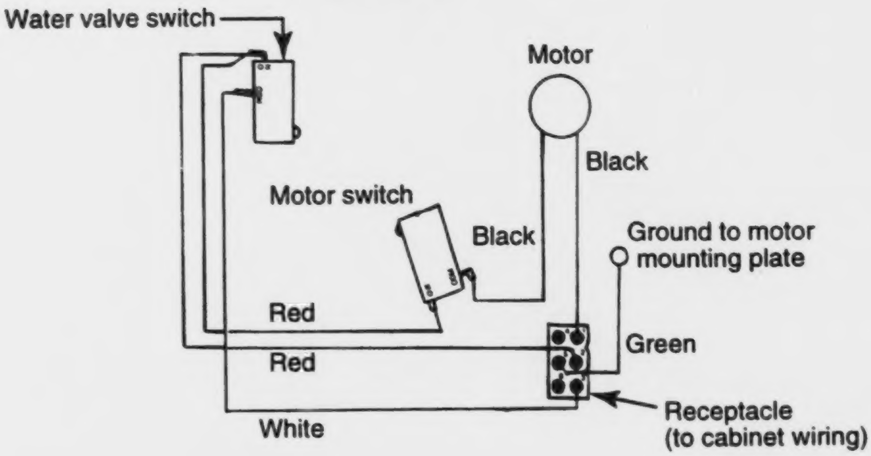
Information Sheet

e. There are two versions of the flex-tray ice maker, but they both function about the same; one uses a thermostat with a mechanical arm and the other uses a thermostat in the electrical circuit.

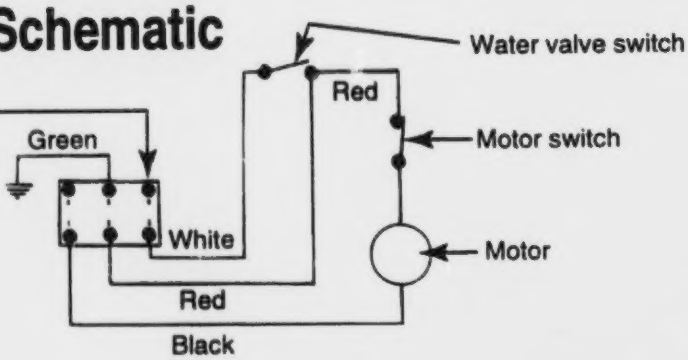
f. The flex-tray does not use a mold heater to assist with releasing formed ice; instead, the cube-holding tray is twisted or flexed to cause the cube ice to release, and this facet of operation makes it different from the other ice maker types.



Pictorial


Water valve switch
Motor
Black
Motor switch
Black
Ground to motor mounting plate
Red
Green
Red
White
Receptacle (to cabinet wiring)

Schematic


Water valve switch
Red
Motor switch
Green
White
Motor
Red
Black

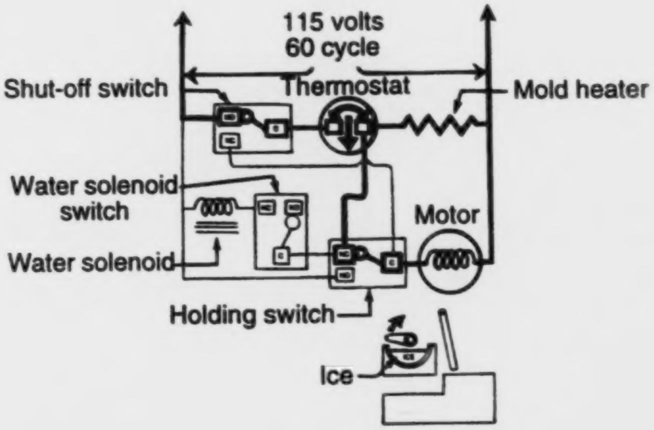
Receptacle connections: Red & black wires to power: white wire to water fill valve solenoid.

Information Sheet

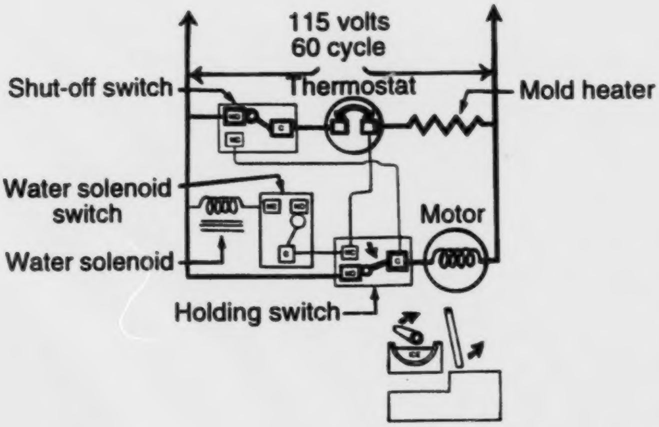
3. How a crescent-shape ice maker works

a. The first revolution in the cycle begins as water enters the ice maker and freezes in the mold, the thermostat closes at 18°F.

b. As the thermostat closes, the circuit is completed to the motor and mold heater, and the motor starts turning the timing cam and ejector blades.

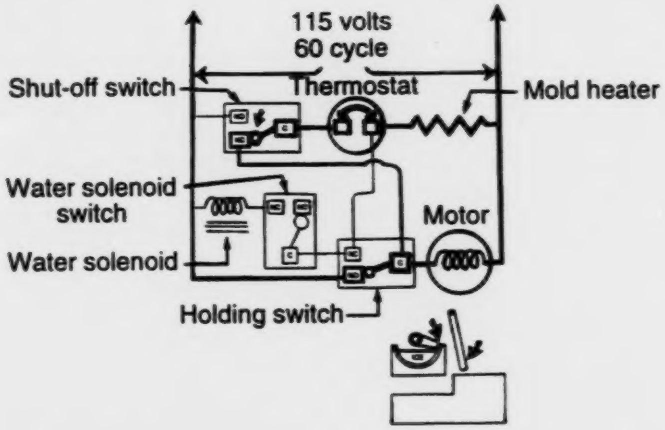

115 volts
60 cycle
Shut-off switch
Thermostat
Mold heater
Water solenoid switch
Motor
Water solenoid
Holding switch
Ice

c. The timing cam moves the holding switch to a normally open position, and the ejector blades reach the cube ice and apply pressure.


115 volts
60 cycle
Shut-off switch
Thermostat
Mold heater
Water solenoid switch
Motor
Water solenoid
Holding switch

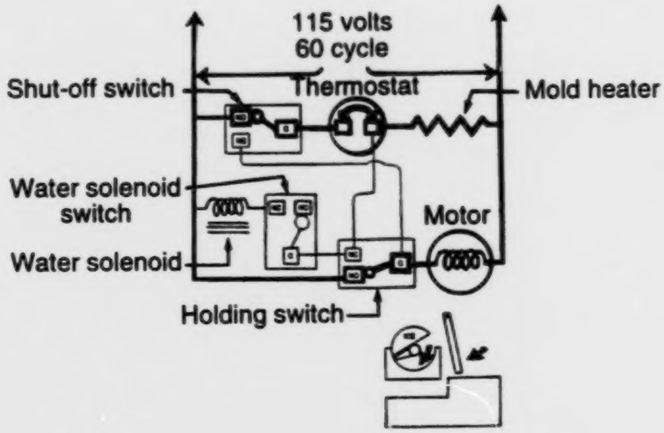
Information Sheet

d. The timing cam raises and lowers the shut-off arm, and switches the shut-off switch to normally closed.


115 volts
60 cycle
Shut-off switch
Thermostat
Mold heater
Water solenoid switch
Motor
Water solenoid
Holding switch

e. Ice is loosened with heat from the mold heater and scooped out by the ejector blades as the timing cam closes the water valve switch.

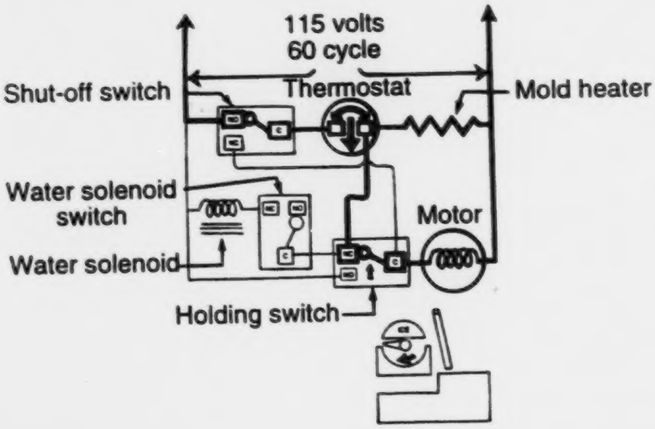
Note: The thermostat is still closed; this creates a shunt circuit and since current seeks the path of least resistance, the water valve solenoid will not energize at this time.


115 volts
60 cycle
Shut-off switch
Thermostat
Mold heater
Water solenoid switch
Motor
Water solenoid
Holding switch

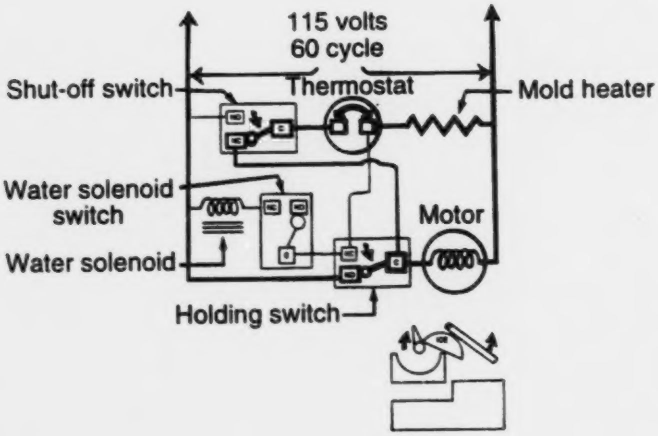
Information Sheet

f. The first revolution ends with ice resting on the ejector blades, the thermostat remains closed, the timing cam activates the holding switch to a normally closed position in preparation for the second revolution of the cycle.

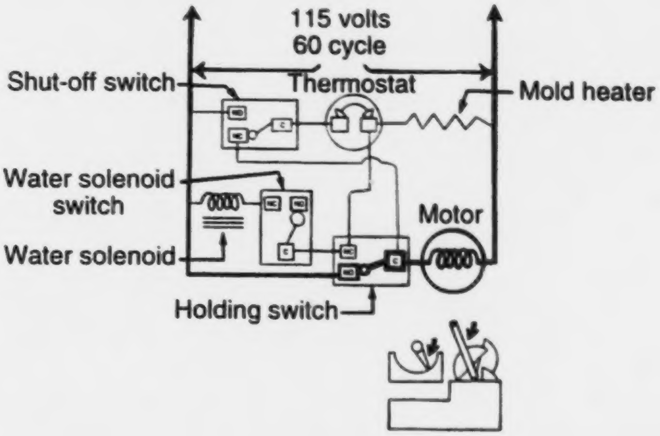
Note: Pre-1965 models of this type ice maker made only one revolution per cycle.


115 volts
60 cycle
Shut-off switch
Thermostat
Mold heater
Water solenoid switch
Motor
Water solenoid
Holding switch

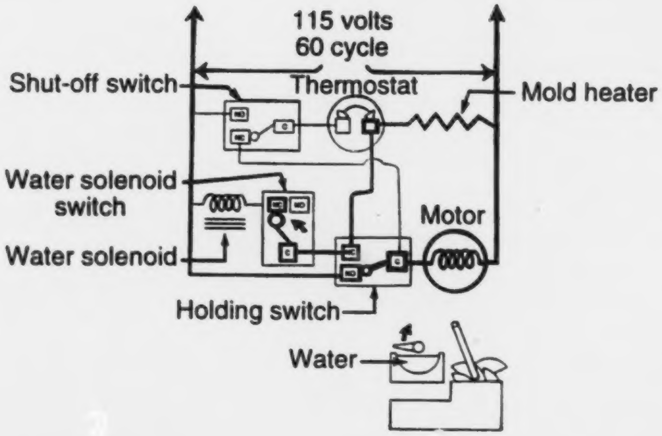
g. The second revolution begins as the timing cam moves the holding switch to the normally closed position.


115 volts
60 cycle
Shut-off switch
Thermostat
Mold heater
Water solenoid switch
Motor
Water solenoid
Holding switch

h. The shut-off arm raises and lowers the shut-off switch to the normally closed position, and ice is dumped into the storage bin.


115 volts
60 cycle
Shut-off switch
Thermostat
Mold heater
Water solenoid switch
Motor
Water solenoid
Holding switch

i. The ice maker thermostat opens at 50°F and deenergizes the mold heater while the timing cam closes the water valve switch which energizes the water valve solenoid, and water enters the ice maker mold until the cam opens the water valve switch again.

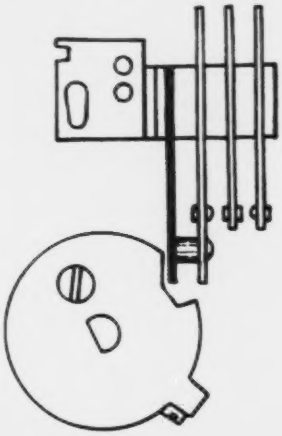

115 volts
60 cycle
Shut-off switch
Thermostat
Mold heater
Water solenoid switch
Motor
Water solenoid
Holding switch
Water

4. How a five-cavity ice maker works

a. Water enters the ice maker mold and freezes.

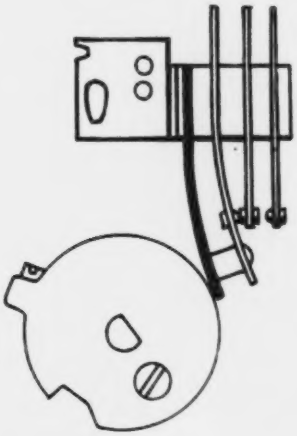
Information Sheet

b. The ice maker thermostat closes at 16°F, and the leaf switch contacts are open during freezing.



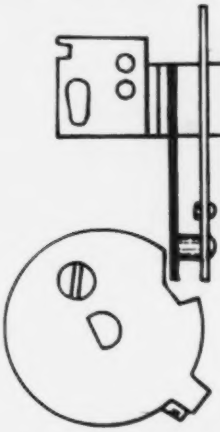
c. If the feeler arm switch is closed, indicating that the feeler arm is in the down position, and the ice bin is empty, the thermostat completes the circuit to the motor and mold heater, and the motor stalls until ice is loosened by the heater.

d. The cam rotates to close leaf switch 1 which bypasses the thermostat and the motor will run regardless of the position of the thermostat.

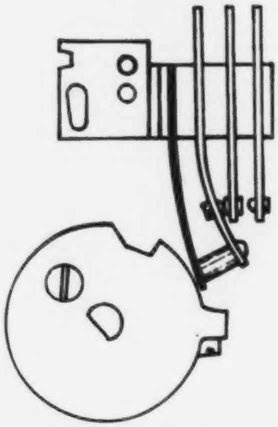


Information Sheet

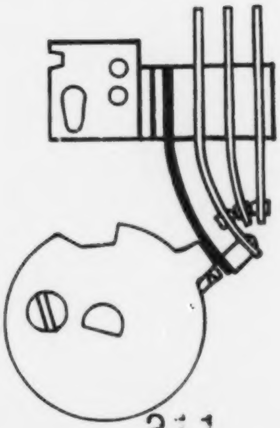
e. Ice cubes are raised in the mold and swept away by the rake assembly as the cam rotates to close leaf switch 2 which energizes the water fill valve solenoid.



f. Leaf switch 2 opens again after 6 seconds, ending the water fill cycle.



g. The actuator leaf falls into the open area on the cam and the cycle is terminated.



Information Sheet

5. **How a flex-tray ice maker works**

   a. Water enters the ice tray and freezes.

   b. The ice maker thermostat closes at 15°F, and the thermostat moves a lever arm which actuates a motor switch, and the motor starts turning the gear mechanism.

   c. The sensor arm moves down into the ice storage bin; if the bin is full the cycle will stop, and if the bin is not full, the arm returns to its original position and the cycle continues.

   d. The cube tray begins to rotate, and at approximately 180°, one corner of the tray hits a stop, but the shaft continues to turn so it twists the tray.

   e. The tray stop is detracted which rapidly releases the tray from its position and this shakes the cubes into me storage bin.

   f. The tray continues to turn until it completes a 360° revolution.

   g. The water fill switch is energized and deenergized by a cam to start the cycle over again.

6. **Storing and dispensing ice**

   a. Regardless of whether ice is produced in ice trays or the latest automatic ice maker, most refrigerators provide for storage and/or on-demand dispensing.

   b. Storage will usually be a container molded to fit in the freezer compartment or freezer compartment door, and extending underneath the ice maker if one is present.

   c. Some models permit on-demand dispensing without opening the refrigerator door and this is convenient and energy saving.

   d. On-demand ice dispensing through the refrigerator door is accomplished by a motor driven auger in the ice storage container.

   e. The auger is activated by pushing a glass or other container against a lever inset in the front of the appliance.

   f. The auger pushes the ice to a hole in the front of the storage container so it can fall through a chute which opens above the activating lever.

Information Sheet

g. In some models, the ice maker dumps ice directly into the dispensing container, and in other models, the ice must be manually loaded into the dispensing container.

h. Some models also dispense cold water at the same location in a similar manner, and other models will dispense whatever soft drink or juice is placed into the dispensing container.

i. A visual check of the components will locate most problems with on-demand dispensers.

j. The auger motor and lever switch are the only electrical components.

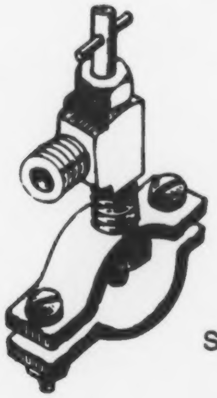
k. Check manufacturer's instructions for specifics about the operation of individual models.

7. Ice maker water supply and control devices

a. The most commonly used source of supply water for an ice maker is the cold water line usually found under the sink in a home and usually adjacent to the area where the refrigerator is installed.

b. The most common way to access supply water is to install a saddle valve on a supply water line.

c. Some saddle valves are self-tapping and simply screw into a supply water line, and other saddle valve types require a technician to drill a hole in the supply line before attaching the saddle valve.



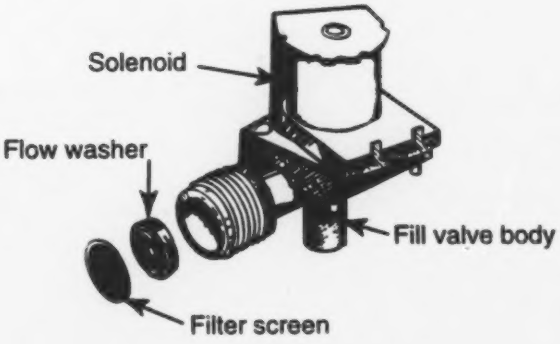
Saddle valve

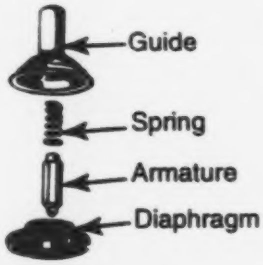
d. The water fill valve operates with a pressure-release mechanism and controls the water supply to an ice maker.

e. The components of a fill valve include a filter screen and flow washer to assure clean water into the valve, and a fill valve body that holds a guide, spring, armature, and diaphragm.

Information Sheet

f. Vinegar is often used to clean water fill valve components because it is acidic enough to remove mineral deposits that tend to build up on valve components.


Solenoid
Flow washer
Fill valve body
Filter screen

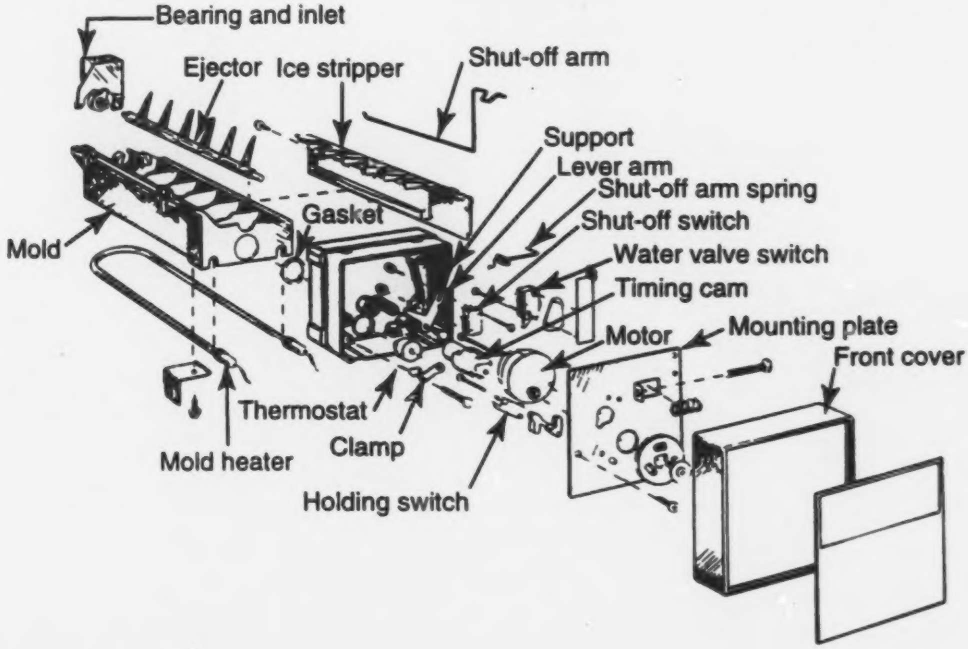

Guide
Spring
Armature
Diaphragm

8. Parts of a crescent-shaped cube ice maker

a. Components and their relationship to each other are usually presented in an illustration called an "exploded view."

b. An exploded view of a crescent shape cube ice maker is a good reference for maintenance, troubleshooting, and repair.

Exploded View


Bearing and inlet
Ejector
Ice stripper
Shut-off arm
Support
Lever arm
Shut-off arm spring
Shut-off switch
Water valve switch
Timing cam
Mold
Gasket
Motor
Mounting plate
Front cover
Thermostat
Clamp
Mold heater
Holding switch

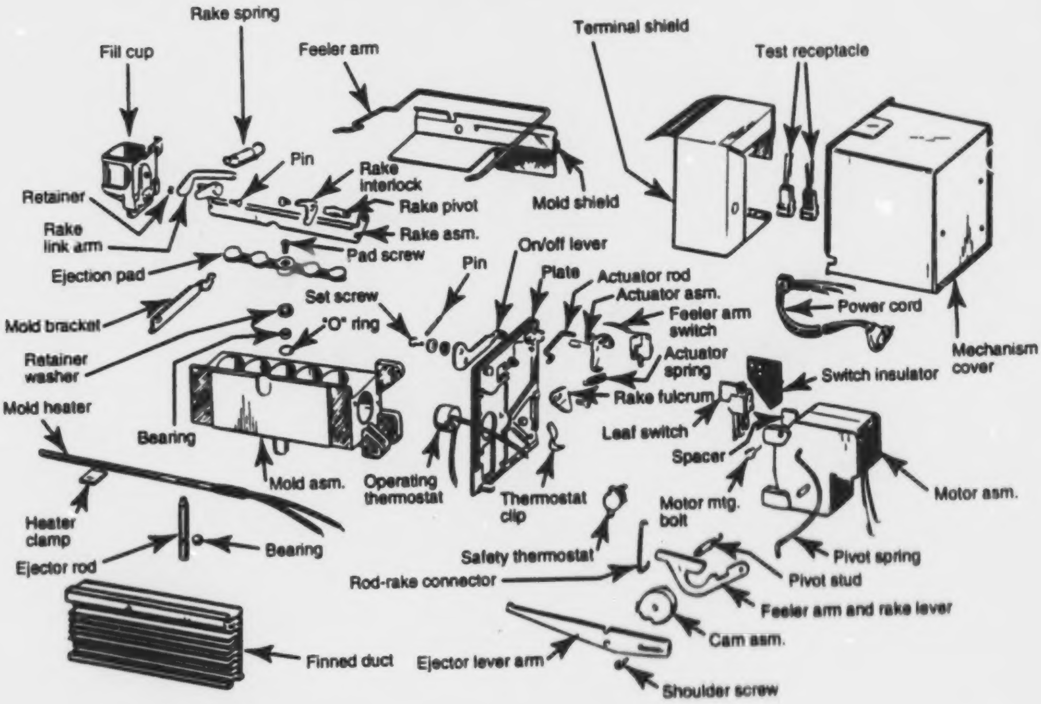
Information Sheet

9. Parts of a five-cavity ice maker

a. In cases where exploded views may not be available, an illustrated parts list shows parts in a general order.

b. An illustrated parts list is valuable for units with many parts that would be difficult to show in a single exploded view or other graphic.

Illustrated Parts List


Rake spring
Fill cup
Feeler arm
Terminal shield
Test receptacle
Pin
Rake interlock
Retainer
Rake pivot
Mold shield
Rake link arm
Rake asm.
Pad screw
On/off lever
Ejection pad
Pin
Plate
Actuator rod
Actuator asm.
Set screw
Feeler arm switch
Power cord
Mold bracket
"O" ring
Mechanism cover
Retainer washer
Actuator spring
Switch insulator
Rake fulcrum
Mold heater
Leaf switch
Bearing
Spacer
Mold asm.
Operating thermostat
Thermostat clip
Motor mtg. bolt
Motor asm.
Heater clamp
Safety thermostat
Pivot spring
Bearing
Ejector rod
Pivot stud
Rod-rake connector
Feeler arm and rake lever
Cam asm.
Finned duct
Ejector lever arm
Shoulder screw

10. Troubleshooting ice makers

a. To operate properly, an ice maker must have:

1) water at the right place and time.

2) electricity of the proper voltage at the right place and time.

3) properly functioning mechanical parts such as gears and levers.

b. Troubleshooting ice makers usually means identifying which of the items in 10a are not happening properly and why.

Information Sheet

c. Take the following steps before checking ice maker components for operation:

  1) make sure water and electricity are available to the ice maker.

  2) make sure the compartment is cold enough to trigger the ice making cycle.

  3) make sure switches, feeler arms, or other control mechanisms are in position to call for making ice.

d. If the qualifications listed in 10c are met, use a troubleshooting chart such as the one in Student Supplement 1 to identify problems with ice maker components.

11. Ice maker service

a. Assuring that water is available to an ice maker usually means checking the water valve and the ice maker water fill valve.

b. The water supply valve is usually a manual valve located under the kitchen sink, at the hot water tank, or some other accessible location.

c. Turn off the main water supply to the building before cleaning or replacing an ice maker water supply valve.

d. Water fill valves frequently have to be removed, disassembled, and cleaned.

Note: See Job Sheet 2.

e. While many parts for ice makers are available, it is frequently more economical to replace the entire ice maker with a replacement kit designed for a specific application.

f. Most ice makers can be easily removed from the refrigerator by unplugging the ice maker from its electrical connection, and loosening or removing a couple of screws.

Note: Replacement kits are available to fit most popular brands of refrigerators.

g. For leaking seals on five-cavity ice makers, there is a special repair kit which requires special tools.

Note: See Job Sheet 5.

h. If you have questions about servicing an ice maker, always consult OEM instructions.

Note: Check with your instructor for information about how to contact brand-name manufacturers.

Domestic Ice Maker Service
Unit 5

Student Supplement 1—Troubleshooting Domestic Ice Makers

A. Problems with crescent-shaped cube ice makers	Checks and remedies
1. Ice maker won't start	Lower the shut-off arm to the lowest position. Check for voltage to the ice maker. Check freezer temperature; should be 18°F or less. Start the motor manually (see illustration). If the motor does not run after manual start, disconnect it from its power source, check for continuity, and replace it if it is open. If the motor runs after manual start, disconnect it from its power source and check motor operation with a test cord. Replace motor if bearings are worn or if it has other mechanical problems. Check thermostat for continuity. Replace thermostat if it is open. Check for "C" to "NC" continuity of holding switch while ejector blade is in starting position. Replace switch if it is open. Check for continuity "C" to "NC" on shut-off switch. Replace it if it has continuity.
2. Water fails to enter mold	Check to see if freezer temperature is 18°F or less. If temperature is above 18°F, check thermostat and refrigeration cycling. Check voltage at water fill valve. If voltage is not present, check water fill valve switch for continuity. Replace switch if cam is in proper position and switch is open. If voltage is available at the water fill valve solenoid, check the solenoid for continuity. Replace valve if solenoid is open. If solenoid has continuity, check volume and pressure of water to the water fill valve. If either volume or pressure is insufficient, check both at the water supply valve. Clean or replace water supply valve if blocked. If volume and pressure are okay to the water fill valve, check for restriction in water valve or water valve screen. Clean as necessary. Check the fill tube for ice blockage. Check the water valve for water leaking through the valve when it is not energized; clean or replace as needed. Check the fill tube heater for continuity, if the unit has a fill tube heater. Replace the heater if it is open.

Student Supplement 1

A. (cont.)	Checks and remedies
3. Ice maker fails to complete cycle	With ejector blades stopped at 10 o'clock position, check the holding switch with switch plunger depressed for continuity between "C" and "NO." Replace the holding switch if it is open. With the ejector blades stopped at 12 o'clock position, check the shut-off switch for continuity between "C" and "NO." Replace the shut-off switch if it is open. With ejector blades at the 4 o'clock position, check the heater and thermostat for continuity, and replace either or both components if you find an open. If the ejector blades will not stop at the end of the cycle, the holding switch is defective; replace it.
4. Undersized ice cubes	Check mold for level; level as needed. Check screen in water valve; clean as needed. Adjust water valve switch. Check bond between thermostat and mold. Check for restriction at saddle valve; clean or replace as needed.
5. Water spills from mold	Check mold for level; level as needed. Check for leak between fill tube and water outlet. Check water valve for water leaking through the valve when it is not energized. Clean or replace valve as needed. Check water fill valve switch adjustment; adjust if needed.
B. Problems with five-cavity ice makers	
1. Not making ice	Check source voltage to ice maker. Make sure manual switch is turned on. Make sure water is available to the appliance. Make sure temperature is 16°F or colder. Place feeler arm in its lowest position. Feel for ice or water in cavities; if not present, proceed to #2. If present, check feeler arm switch for continuity. Adjust or replace if open. Check safety thermostat for continuity. Replace if open. Check operating thermostat for continuity. Replace if open. Visually check leaf switch. Replace if out of alignment or broken. If water is present in cavities, check for voltage to motor. If voltage is present and motor is not turning, check motor for continuity. Replace if open. If voltage is not present, check switches and wiring. If ice is present, check continuity of motor. Replace if open. If motor is not open, proceed to #5.

Student Supplement 1

B. (cont.)	Checks and remedies
2. Will not fill with water	Check voltage to water fill valve solenoid. If voltage is present, check if water is getting through the fill valve. If no water is getting through the valve, check continuity of solenoid. Replace valve if solenoid is open. If solenoid is not open, check volume and pressure of water to the fill valve. If either volume or pressure is insufficient, check both at the water supply valve. Clean or replace water supply valve if blocked. If volume and pressure are okay to the water fill valve, check for restriction in water valve or water valve screen. Clean as necessary. If voltage is not present at the solenoid, check leaf switches and wiring. Repair or replace as needed. If water is getting through the valve, check fill tube for ice blockage. If blocked, check fill tube heater for continuity, if the unit has a fill tube heater. Replace if open. If the unit has no fill tube heater, check water fill valve for water leaking through the valve when it is not energized. Clean or repair as needed.
3. Excess water freezes in storage container	Check for water leaking around ejector rod. If leaking, repair seals, etc. with special kit. If ejector rod seal is not leaking, check water valve for water leaking through the valve when it is not energized. Clean or replace as needed. Check position of fill tube; reposition if needed. Check ice maker for level; level as needed. Time length of fill cycle. If cycle is too long, check leaf switches and thermostat. Replace switches or thermostat if either is stuck or closed.
4. Cubes to small	Time water fill cycle and adjust as necessary. Check volume and pressure of water to the water fill valve. If either volume or pressure is insufficient, check both at the water supply valve. Clean or replace water supply valve if blocked. If volume and pressure are okay to the water fill valve, check for restriction in water valve or water valve screen. Clean as necessary.
5. Will not eject cubes	Check voltage to mold heater. If voltage is present and heater is not warm, check continuity of mold heater. Replace if open. If ice melts, check ejector rod. If the ejector rod is stuck, remove it and replace the rod and adjacent components with a special kit. **Note: See Job Sheet 5.** If ejector rod is not stuck, check shoulder screw and rake assembly. Repair or replace as needed.

B. (cont.)	**Checks and remedies**
6. Makes too much ice	Check feeler arm for proper position and function. If feeler arm is okay, check position and adjustment of feeler arm switch. Adjust or replace as needed.
C. Problems with flex-tray ice makers	
1. Ice maker will not start	Check freezer temperature; should be 15°F or lower. Make sure voltage is available inside the ice maker. If voltage is not available, check wiring and connections. Make sure sensor arm is in up position. If not, check arm and its connection to the ice maker. Check position of mold. Look to see if the motor is turning. If not, check ice maker thermostat or sensor element. If ice maker thermostat contacts are open and temperature is 15°F or below, replace the thermostat. If sensor element does not have arm in proper position, replace the element. If thermostat or sensor element check okay, check continuity of motor control switch. Replace switch if it is open.
2. Water fails to enter mold	Make sure freezer temperature is 15°F or lower. Check voltage-at water fill valve. If voltage is not present, check water fill switch continuity. Replace fill switch if open. If voltage is available at the water fill valve solenoid, check the solenoid for continuity. Replace valve if solenoid is open. If the solenoid has continuity, check volume and pressure of water to the water fill valve. If either volume or pressure is insufficient, check both at the water supply valve. Clean or replace water supply valve if blocked. If volume and pressure are okay to the water fill valve, check for restriction in water valve or water valve screen. Clean as necessary. Check the fill tube for ice blockage. Check the water valve for water leaking through the valve when it is energized. Clean or replace as needed.
3. Water spills from mold	Make sure mold is level; level as needed. Check position of water fill tube; adjust as needed. Check the water valve for water leaking through the valve when it is not energized. Clean or replace as needed. Check water fill switch for continuity after mold fills with water. Replace if fill switch is not open. Check if cubes are being ejected. If not, check mold flexing mechanism and operation. Repair as needed.

Student Supplement 1

C. (cont.)	Checks and remedies
4. Cubes stuck together in storage bin	Make sure water is not spilling from mold; see item 3. Check freezer temperature; should be 15°F or lower. Make sure sensing element or ice maker thermostat operates at proper temperature. Check mechanical elements of sensor element and motor switch actuator. Repair springs or other parts as needed.
5. Makes too much ice	Check actuator sensor arm and operation. Check for pin of switch actuator to be in groove of final stage timing gear. Repair or replace as needed.
6. Undersized ice cubes	Make sure mold is level; level as needed. Measure amount of water dispensed from the fill spout during a fill cycle. If not 200 cc's, adjust water valve switch. **Note: See Job Sheet 6.** Check volume and pressure of water to the water fill valve. If either volume or pressure are insufficient, check both at the water supply valve. Clean or replace water supply valve if it is blocked. If volume and pressure are okay to the water fill valve, check for restriction in water valve or water valve screen. Clean as necessary.

ACRD-229

Domestic Ice Maker Service
Unit 5

Assignment Sheet 1—Use Troubleshooting Guides to Solve Domestic Ice Maker Problems

Name ______________________________ Overall Rating ____________

Evaluation Criteria	**Rating**
Possible causes proper for Complaint 1	______
Possible cause proper for Complaint 2	______
Possible cause proper for Complaint 3	______

Directions: Read the following scenarios and use the troubleshooting guidelines in Student Supplement 1 to identify the most likely cause(s) of the problem(s) given.

Example: A service work order states that a customer complains that a crescent-shaped cube ice maker quit making ice. Upon arrival at the location, you find that the ice maker goes through its cycle, but you feel no water entering the mold. The water fill tube appears to be open and clear. You pull the appliance out from the wall and verify that voltage is available at the water fill valve.

Possible causes are:

- open water fill valve solenoid.
- clogged water fill valve screen.
- clogged water supply valve.

Complaints:

1. The service work order states that the customer complains that a crescent-shaped cube ice maker quit making ice. Upon arrival at the location, you find that the ice maker will not start. You find voltage available to the ice maker and the freezer temperature to be 8°F. You attempt to start the motor manually, but it does not run.

   Possible causes are:

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

Assignment Sheet 1

2. The service work order states that the customer complains that large chunks of ice are accumulating in the ice storage container underneath the ice maker. Upon arrival at the location, you identify the ice maker as a five-cavity ice maker. You find water dripping off of the ejector rod.

   Possible cause is: ______________________________.

3. The service work order states that the customer complains that the ice maker quit making ice. Upon arrival at the location, you identify the ice maker as a flex-tray ice maker. You observe the sensor arm moving down and back up, but no water enters the mold. The water fill tube appears to be open. You pull the appliance out from the wall and determine that voltage is not available to the water fill valve.

   Possible cause is: ______________________________.

Domestic Ice Maker Service
Unit 5

Job Sheet 1—Install a Water Line to a Refrigerator Equipped With an Ice Maker

Name ______________________ Attempt Number ________

Date ______________________ Overall Rating ________

Evaluation Criteria	**Rating**
Saddle valve properly installed	______
Tubing loop left at back of appliance	______
Water line cleaned and fill valve properly accessed	______
Ice maker operational	______

A. Tools and materials

Refrigerator with ice maker as selected by instructor
Appropriate service literature
Refrigeration technician's hand tools
Roll of 1/4" o.d. copper tubing
Water line saddle valve
3/8" drill with 5/32" and 3/8" drill bits
Tubing cutter
Container to catch water
Safety glasses
Clean shop cloth(s)
Service Work Order with Operating Conditions Chart

B. Procedure

☐ 1. Read the manufacturer's installation instructions.

☐ 2. Put on safety glasses.

☐ 3. Place the refrigerator in a proper location so that the water fill valve can be accessed.

☐ 4. Locate the nearest cold water supply line; in most houses, the nearest supply line is beneath the kitchen sink.

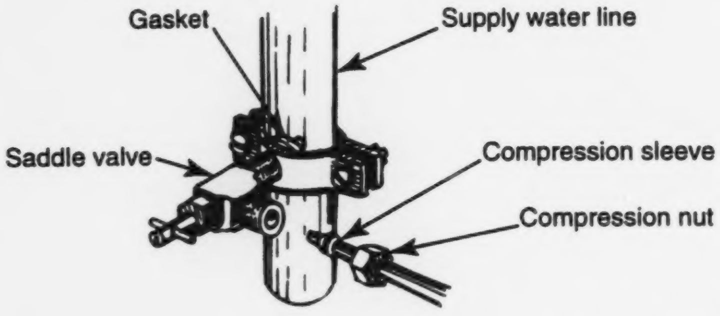
☐ 5. Shut off the water supply to the line you are tapping, or shut off the main water supply if no shut-off is present.

☐ 6. Open a faucet to drain water from the line.

Job Sheet 1

☐ 7. If you are not using a self-tapping saddle valve, drill a 5/32" hole in the water line.

☐ 8. Place the saddle valve on the water line and secure it in place.


Gasket
Supply water line
Saddle valve
Compression sleeve
Compression nut

☐ 9. Make sure the inlet of the valve is firmly secured in the water line.

☐ 10. Make sure the gasket on the saddle valve is properly in place.

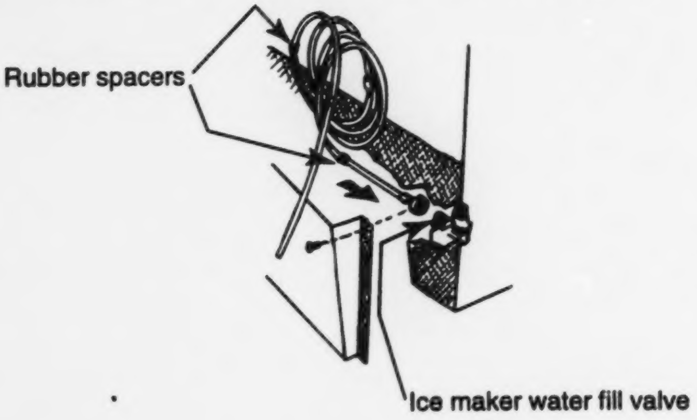
☐ 11. Measure the distance from the water supply outlet at the saddle valve to the entrance of the water fill valve on the refrigerator.

☐ 12. Add an additional four feet of tubing to your measurement in Step 11 so you can leave a loop of copper tubing behind the refrigerator; this will permit the refrigerator to be moved without damaging the water line.

☐ 13. Check to see if the ice maker water line will have to run through the bottom of a kitchen cabinet, and drill a 3/8" hole if you need one.

☐ 14. Connect the tubing to the saddle valve.

☐ 15. Make three or four loops in the tubing behind the refrigerator.


Rubber spacers
Ice maker water fill valve

Job Sheet 1

☐ 16. Close the valve stem on the saddle valve; this will also puncture the copper line if you are using a self-tapping valve.

☐ 17. Turn on main water supply and close the faucet you opened to drain the water line.

☐ 18. Place a container at the end of the water line to catch water.

☐ 19. Open the valve stem on the saddle valve.

☐ 20. Allow a small amount of water to run through the water line to flush it.

☐ 21. Close the valve stem on the water valve.

☐ 22. Remove refrigerator panels as necessary to gain access to the water fill valve.

☐ 23. Connect the water line to the fill valve and turn on the saddle valve.

☐ 24. Check for leaks.

☐ 25. Verify that water reaches the ice maker and that the ice maker is operational.

☐ 26. Replace any panels you had to remove.

☐ 27. Have your instructor check your installation.

☐ 28. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ____

____

____

Domestic Ice Maker Service
Unit 5

Job Sheet 2—Disassemble and Clean a Water Fill Valve

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
Water fill valve removed safely	______
Fill valve disassembled and components cleaned	______
Fill valve reassembled and reinstalled properly	______
Ice maker checked to verify fill valve operation	______

A. Tools and materials

Refrigerator with ice maker as selected by instructor
Appropriate service literature
Refrigeration technician's hand tools
Container to catch water
Vinegar for use as cleaning fluid
Safety glasses
Clean shop cloth(s)
Service Work Order with Operating Conditions Chart

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Pull the refrigerator out from the wall to gain access.

☐ 3. Shut off the water supply at the saddle valve.

☐ 4. Remove panels as necessary to access the water fill valve.

☐ 5. Unhook the water line to the fill valve and catch any excess water in a container.

☐ 6. Remove the water fill valve and place it on a clean shop cloth.

☐ 7. Use a screwdriver to remove the filter screen and flow washer.

☐ 8. Remove the solenoid.

☐ 9. Remove the plate from the top of the water fill valve.

Job Sheet 2

☐ 10. Remove the guide, spring, armature, and diaphragm.

☐ 11. If the diaphragm is stuck to the body of the valve, work it loose gently, but do not attempt to pry it loose with any sharp object because the diaphragm is easy to damage.

☐ 12. Wash the fill valve body, diaphragm, armature, filter screen, and flow washer in vinegar.

Note: If you do not have vinegar in your supplies, you can wash the components under running water, but vinegar does the best job because it removes mineral deposits that tend to build up in water fill valves.

Caution: Do not use any cleaning fluid that would be harmful to someone if ingested.

☐ 13. Hold the diaphragm up to the light and inspect it to be sure that the two small holes at the sides of the diaphragm are clear.

☐ 14. Reassemble the valve.

☐ 15. Be sure that the diaphragm fits down into the groove in the valve body; if it does not fit properly, water will flood the ice compartment.

☐ 16. Turn on supply water and check the ice maker to be sure water is flowing properly through the water fill valve.

☐ 17. Have your instructor check your work.

☐ 18. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

____

____

Domestic Ice Maker Service
Unit 5

Job Sheet 3—Replace a Thermostat in a Crescent-Shaped Cube Ice Maker

Name ______________________________ Attempt Number __________

Date ______________________________ Overall Rating __________

Evaluation Criteria	Rating
Old thermostat properly removed	______
New thermostat properly installed	______
Proper thermostat operation verified	______

A. Tools and materials

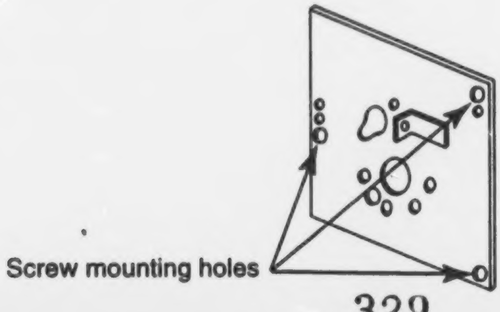
Crescent-shaped ice cube maker
Appropriate service literature
Refrigeration technician's hand tools
Wire connectors
Alumilastic
Safety glasses
Clean shop cloth(s)

B. Procedure

☐ 1. Put on safety glasses.

Note: This procedure assumes that the crescent-shaped ice cube maker has been removed from the appliance; if your instructor has selected a different type of ice maker for this activity, the procedure may vary, so check with your instructor if you have questions.

☐ 2. Remove the front cover of the ice cube maker, and then remove the three screws that hold the mounting plate; do not remove any other screws from the mounting plate.



Job Sheet 3

☐ 3. Place the mounting plate and its attached components out of the way on a clean shop cloth.

☐ 4. Cut the thermostat wires.

☐ 5. Remove the screw from the thermostat clamp/

☐ 6. Remove the thermostat.

☐ 7. Clean off the old alumilastic from the ice maker mold.

☐ 8. Put alumilastic on the new thermostat.

☐ 9. Place the new thermostat in position.

☐ 10. Replace the thermostat clamp and screw.

☐ 11. Connect the thermostat wires.

☐ 12. Have your instructor check your work.

☐ 13. Replace the mounting plate.

☐ 14. Replace the front cover of the ice maker.

☐ 15. Start the refrigerator and check the ice cube maker to be sure the thermostat is properly controlling the cycle.

☐ 16. Have your instructor check your work again.

☐ 17. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ____

____

____

Domestic Ice Maker Service
Unit 5

Job Sheet 4—Replace the Mold Heater in a Crescent-Shaped Cube Ice Maker

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	Rating
Old mold heater properly removed	______
New mold heater properly installed with retaining screws	______
Ice maker operation verified after replacement	______

A. Tools and materials

Refrigerator with crescent shape cube ice maker
Appropriate service literature
Refrigeration technician's hand tools
Replacement mold heater
Safety glasses
Clean shop cloth(s)

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Shut off the water supply to the ice maker.

☐ 3. Unplug the refrigerator from its power source.

☐ 4. Remove the ice maker from the refrigerator.

☐ 5. Allow the ice maker to warm to room temperature and then remove the cover.

Note: If ice maker is still too cold, some of the plastic parts could be damaged when you attempt to remove them.

☐ 6. Remove the ice stripper from the side of the mold.

☐ 7. Remove the three screws holding the mounting plate.

☐ 8. Place the mounting plate and other components out of the way on a clean shop cloth.

☐ 9. Remove the thermostat from the mold.

Job Sheet 4

☐ 10. Cut the mold heater wires.

☐ 11. Remove the four bolts that hold the mold to the support housing.

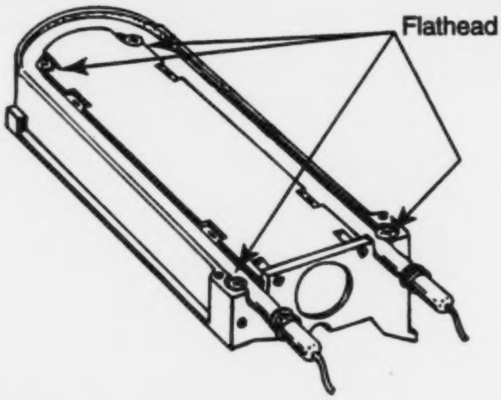
☐ 12. Remove the mold from the support housing and be very careful not to damage or destroy the thermostat gasket.

☐ 13. Pry the old mold heater out of the mold.

☐ 14. Clean the old alumilastic from the mold groove.

☐ 15. Install the new heater with new alumilastic and secure it with the retaining screws that come with the replacement heater kit.

Note: Original heaters do not have retaining screws, but replacement heaters do have retaining screws and there are holes predrilled for that purpose.



☐ 16. Clean the old alumilastic from the mold thermostat recess and from the mold thermostat.

☐ 17. connect the mold to the support housing, and be careful not to damage the thermostat gasket.

☐ 18. Put new alumilastic on the thermostat.

☐ 19. Install the thermostat and clamp.

☐ 20. Connect the heater wires.

☐ 21. Replace the mounting plate.

☐ 22. Tighten the mounting plate screws.

☐ 23. Replace the ice stripper.

Job Sheet 4

☐ 24. Have your instructor check your work.

☐ 25. Turn on water supply to the ice maker and start the refrigerator.

☐ 26. Manually start ice maker into cycle to verify correct operation.

☐ 27. Have your instructor check your work again.

☐ 28. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ____

____

____

Domestic Ice Maker Service
Unit 5

Job Sheet 5—Replace Mold, Seal, Bearing, and Retainer in a Five-Cavity Ice Maker

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
Ice maker properly disassembled	______
Retainer installation tool used effectively	______
All replacement parts lubricated with silicon	______
Injector rod and pad properly serviced	______
Unit leak checked	______

A. Tools and materials

Five-cavity ice maker
Appropriate service literature
Refrigeration technician's hand tools
Seal remover (Robinair #14368 or equivalent)
Retainer washer installation tool (Robinair #14173 or equivalent)
Seal assembly
Retainer remover
Silicon lubricant
Safety glasses
Clean shop cloth(s)

B. Procedure

☐ 1. Put on safety glasses.

Note: This procedure assumes that the five cavity ice maker has been removed from the appliance.

☐ 2. Remove the mechanism cover by removing the plastic plugs at the top and bottom of the ice maker.

☐ 3. Remove the terminal shield.

☐ 4. Remove the ejection pad screw.

☐ 5. Rotate the cam until the shoulder screw is at the 12 o'clock position.

☐ 6. Remove the shoulder screw.

Job Sheet 5

☐ 7. Remove the pivot stud.

☐ 8. Remove the ejector lever arm from the ejector rod.

☐ 9. Remove the ejection pad.

☐ 10. Slide the ejector rod out of the bottom of the mold.

☐ 11. Remove the metal washer from the mold with the special removal tool.

Note: Without the right tool such as Robinair Tool #14368 you may damage the unit.

☐ 12. Remove the bearing and seal.

☐ 13. Clean and inspect the recess in the mold.

☐ 14. Apply a small amount of silicon lubricant to the bearing and seal recess.

☐ 15. Apply a small amount of silicon lubricant to the shaft hold in the mold, to the new bearing, to the seal, and also to the shaft of the installation tool.

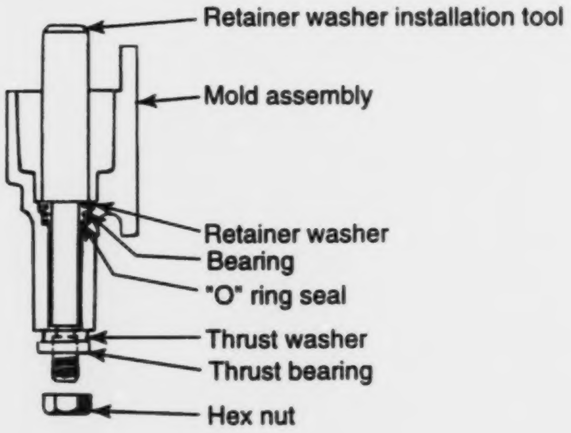
Note: You must use a special installation tool such as Robinair Tool #14173.

☐ 16. Place the retainer washer, bearing, and seal on the installation tool.

Note: Be sure to place the retainer washer onto the installer with the "crowned" side against the shoulder of the tool.

☐ 17. Insert the tool into the mold, and position the retainer washer in the mold recess.

☐ 18. Place the thrust washer, thrust bearing, and hex nut on the installation tool.


Retainer washer installation tool
Mold assembly
Retainer washer
Bearing
"O" ring seal
Thrust washer
Thrust bearing
Hex nut

☐ 19. Seat the retainer by tightening the hex nut onto the installation tool.

Job Sheet 5

☐ 20. Remove the installer and inspect the retainer washer.

Note: If the retainer is properly seated, it should flatten the washer.

☐ 21. Inspect the ejector rod for rough spots.

☐ 22. Install a new bearing on the ejector rod.

☐ 23. Place a small amount of silicon lubricant on the ejector rod.

☐ 24. Insert the ejector rod from the bottom of the mold.

☐ 25. Put the ejector rod all the way down.

☐ 26. Place the ejector pad in the bottom of the mold.

☐ 27. Check the clearance between the pad and the side of the mold.

☐ 28. If the pad touches the side of the mold, remove the pad, rotate it 180°, and then place it back into the bottom of the mold and check it for fit.

☐ 29. Tighten the screw in the center of the pad.

☐ 30. Move the rod up and down to make sure the pad doesn't bind on the mold.

☐ 31. Insert the ejector lever into the slot on the ejector rod.

☐ 32. Replace the pivot stud.

☐ 33. Replace the shoulder screw.

☐ 34. Replace the terminal shield.

☐ 35. Replace the mechanism cover.

☐ 36. Fill the mold with water and check for leaks around the ejector rod.

☐ 37. Have your instructor check your work.

☐ 38. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ____________________

____

____

Domestic Ice Maker Service
Unit 5

Job Sheet 6—Adjust the Water Valve Switch in a Flex-Tray Ice maker

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	Rating
Water from fill spout collected and measured in cc's	______
Water supply adjustment properly made	______
Adjusted water supply rate verified in cc's	______

A. Tools and materials

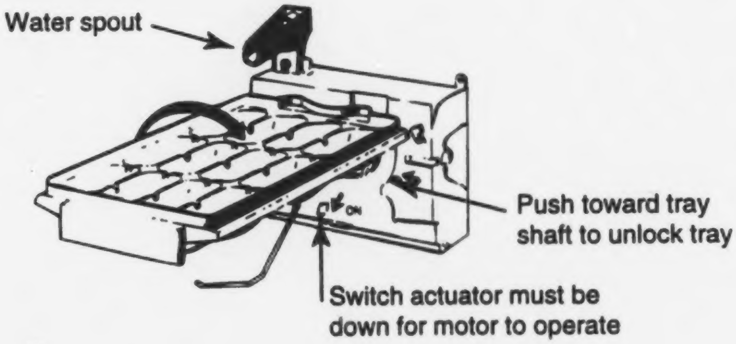
Refrigerator with flex-tray ice maker
Appropriate service literature
Refrigeration technician's hand tools
Container graduated in cc's (baby bottle or medicine bottle)
Clean shop cloths
Safety glasses

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Manually start the ice making cycle by pushing the tray lock lever towards the tray, and then turning the tray clockwise until the gears engage.

☐ 3. As the cycle continues, wait for the end of the cycle and place the graduated container under the water spout.


Water spout
Push toward tray shaft to unlock tray
Switch actuator must be down for motor to operate

Job Sheet 6

☐ 4. Measure all the water dispensed from the fill spout; your graduated container should have 200 cc's of water in it.

☐ 5. Evaluate the need for more or less water by adding or subtracting from the 200 cc mark.

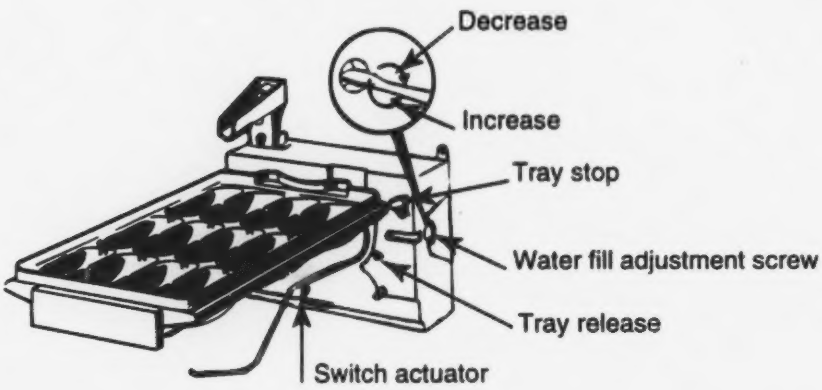
☐ 6. Remove the plug over the adjusting screw slot on the right hand side of the ice maker.

☐ 7. Insert a screwdriver into the adjust screw slot.

☐ 8. If your evaluation in Step 5 indicated a need to decrease the amount of water, turn the adjusting screw clockwise one complete revolution for each 20 cc's of decrease in water supply.

☐ 9. If your evaluation in Step 5 indicated a need to increase the amount of water, turn the adjusting screw counterclockwise one complete revolution for each 20 cc's of increase in water supply.

Example: If you need only 10 cc's more water, turn the adjusting screw counterclockwise one half revolution.



☐ 10. Manually start the ice maker cycle again.

☐ 11. Collect the water from the fill spout at the end of the cycle.

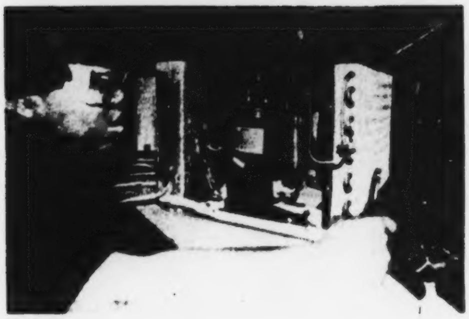
☐ 12. Verify that you have properly adjusted the water supply.

☐ 13. Have your instructor check your work.

☐ 14. Clean up area and return tools and materials to proper storage.

Job Sheet 6

Evaluator's Comments: ______________________________



Window Air Conditioner Service
Unit 6

Objective Sheet

Unit Objective

After completing this unit, the student should be able to use a troubleshooting chart, clean a window air conditioner, install a window air conditioner, replace a fan motor, and install a hard start kit. The student should also be able to replace a liquid-line filter-drier, service a capillary tube, charge a window air conditioner, and replace a compressor. The student should demonstrate these competencies by completing the assignment and job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to window air conditioner service with their correct definitions.
2. Complete statements about the objectives of window air conditioning.
3. Identify mechanical components of a window air conditioner.
4. Identify electrical components of a window air conditioner.
5. Identify window air conditioner cabinet parts.
6. Complete statements about window air conditioner data plates.
7. Complete statements about compressor data plates.
8. Solve problems about electrical requirements for window air conditioner installation.
9. Select true statements about windows and other openings.
10. Solve problems about installing a window air conditioner.
11. Complete statements about evaluating equipment condition.
12. Select true statements about investigating possible causes of problems.
13. Solve problems about determining actual causes of problems.
14. Solve problems about servicing electrical components.
15. Complete statements about replacing electrical components.

Objective Sheet

16. Solve problems about servicing refrigeration components.
17. Select true statements about safety while replacing refrigeration components.
18. Solve problems about servicing capillary tubes.
19. Use a troubleshooting guide to find causes of customer complaints. (Assignment Sheet 1)
20. Install a window air conditioner. (Job Sheet 1)
21. Clean a window air conditioner. (Job Sheet 2)
22. Replace a fan motor. (Job Sheet 3)
23. Install a hard start kit. (Job Sheet 4)
24. Troubleshoot a control switch. (Job Sheet 5)
25. Replace a liquid line filter-drier. (Job Sheet 6)
26. Charge a window air conditioner using a charging cylinder. (Job Sheet 7)
27. Charge a window air conditioner using charging scales. (Job Sheet 8)
28. Evaluate a window air conditioner charge using a superheat charging chart. (Job Sheet 9)
29. Service a capillary tube. (Job Sheet 10)
30. Replace a compressor. (Job Sheet 11)

Window Air Conditioner Service
Unit 6

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction or individual learning activities. Study the specific objectives to determine the order in which you will present the objectives.
2. Review Teaching Suggestions section that follows. Plan for classroom activities.
3. Plan enrichment of exceptional students as well as accommodation of special needs students.
4. Add graphic materials or overhead transparencies as needed.
5. Develop teaching plan. Adjust for different learning styles.
6. Make copies of the Unit Evaluation Form.

Delivery and Application

7. Provide students with unit of instruction.
8. Discuss unit and specific objectives.
9. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic skills when applicable.
10. Discuss assignment and job sheets, and demonstrate the job sheets. Review criteria for evaluation of the activity.

Evaluation

11. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.
12. Make copies of the written test. Add or modify test items as needed.
13. Give written test.

Teaching Suggestions

Note: Skill areas appearing in boldface type in the Teaching Suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: a SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

1. Present Objectives 3 and 4 as complementary objectives. Use the presentation to show how mechanical and electrical components function together in a window air conditioning system. Skill areas: **Basic skills, science, listening, and reading.**

Suggested Activities

2. Stress safety along with the presentation of Objective 8. Talk about the potential of undersized and oversized power sources, their problems with safe operation, and their effects on system performance, and the responsibilities of the technician in assuring safe power connections. Repeat the safety elements when you present Objectives 14 and 15. Skill areas: **Personal management skills, responsibility.**
3. Combine the presentation of Objective 19 with the "window Air Conditioning Guide" in Student Supplement 2. Step students through the troubleshooting guide so they'll be well prepared to put the guide into action in the assignment and job sheets that follow. Skill areas: **Basic skills, listening, and reading.**
4. When you review the job sheets, be sure to point out the Service Work Order that accompanies the job sheets. Impress students with the importance of the SWO not only for company bookkeeping, but for customer relations. Use job sheet discussions to show why concern for customers is an important part of every service call. Skill areas: **Interpersonal skills, customer service.**

Resources Used in Developing This Unit

1. *The Air Conditioning, Heating and Refrigeration News HVAC/R Source Guide.* Troy, MI: Business News Publishing Company, 1993.
2. Wantiez, Gary W. *Air Conditioning and Refrigeration, Domestic Refrigeration.* Stillwater, OK: The Mid-America Vocational Curriculum Consortium, 1984.
3. Whitman, William C. and William M. Johnson. *Refrigeration & Air Conditioning Technology,* 2nd ed. Albany, NY: Delmar Publishers, Inc., 1991.

Suggested Supplemental Resources

1. To obtain service manuals for Whirlpool window air conditioners, call the Whirlpool Assistance Center at 1-800-253-1301. Ask for the Parts Department. Service manuals range in price from $12 to $15, depending on the model.
2. To obtain free service manuals for Friedrich room air conditioners, call 210-225-2000, extension 405. Be sure to specify the model number. For technical assistance for Friederich room air conditioners, call 201-225-2000, extension 407. Be sure to have the model number available.
3. For other service manual or technical assistance contact your local dealer for the brand name air conditioner for which you require service.

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Suggested Activities

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

Window Air Conditioner Service
Unit 6

Answers to Assignment Sheet 1

Scenario A

1. Broken thermostat

Scenario B

1. Loose or broken wires.
2. Broken run capacitor.
3. Broken external overload.
4. Broken compressor (electrical problem)
5. Broken compressor (stuck).

Scenario C

1. Fan or blower wheel binding.
2. Broken run capacitor.
3. Broken fan motor.
4. Loose or broken wiring.

Scenario D

1. Outside air intake open.
2. Improper refrigerant charge.
3. Compressor valves not holding.

Scenario E

1. Walk outside and observe the condition of the condenser coil and feel of the air blowing out of the condenser.

Window Air Conditioner Service
Unit 6

Answers to Written Test

1.
   a. 5
   b. 8
   c. 2
   d. 10
   e. 12
   f. 7
   g. 9
   h. 1
   i. 4
   j. 11
   k. 3
   l. 6

2.
   a. sensible
   b. latent, moisture, humidity
   c. heat pump, electrical
   d. filter
   e. fan, RPM
   f. dampers

3.
   a. 4
   b. 5
   c. 6
   d. 15
   e. 16
   f. 13
   g. 17
   h. 14
   i. 18
   j. 12
   k. 11
   l. 10
   m. 9
   n. 8
   o. 7
   p. 1
   q. 2
   r. 3

4.
   a. 5
   b. 3
   c. 4
   d. 2
   e. 7
   f. 6
   g. 1

5.
   a. 5
   b. 13
   c. 7
   d. 9
   e. 3
   f. 1
   g. 4
   h. 8
   i. 6
   j. 12
   k. 11
   l. 2
   m. 10

6.
   a. servicing
   b. 1) manufacturer's
      2) model
      4) refrigerant
   c. 2) certifying
      3) BTUH

7.
   a. replacing
   b. top, side
   c. 2) identification
      5) phase
   d. F.L.A.
   e. 1) month, year
      2) plant
      3) shift
   f. Encoded
   g. not usually

8.
   a. 3)
   b. 1)

9. a, b, c, f, g, h

Answers to Written Test

10. a. 2)
    b. 3)
    c. 2)

11. a. visual
    b. cleanliness
    c. air flow
    d. sounds
    e. looking, listening
    f. temperatures, pressures, temperature, pressure (answers may be reversed)

12. c, d, e, f

13. a. 3)
    b. 3)

14. a, d, e, f

15. a. 1) poles
       2) contacts
       3) fasteners
       4) connections
       5) ratings
    b. 1) dimensions
       2) diameter
       3) rotation
       4) horsepower

16. a. 3)
    b. 1)

17. a, c, d, e

18. a. narrow
    b. 2) inside
       3) compressor
       4) refrigerant
    c. cleaned, cleaners
    d. restricted

19. a. replaced
    b. 1) refrigerant line
       2) Btuh
       3) compressor
       4) refrigerant
       5) oil
       6) accessories
    c. operating parameters
    d. electrical
    e. liquid line drier
    f. compressor

Window Air Conditioner Service
Unit 6

Written Test

Name ______________________ Date __________ Score __________

1. Match the terms on the right with their correct definitions.

_______ a. An agency that certifies heating and cooling capacity ratings and electrical inputs of all air conditioners that bear the agency seal

_______ b. A device for removing particles from air

_______ c. A variety of putty-like compounds including silicon and acrylic products used to seal a joint and make it watertight

_______ d. Water resulting from cooling moist air below its dew point

_______ e. The ratio of energy consumed to energy produced which for air conditioners is determined by dividing the cooling capacity in BTUH by power input in watts

_______ f. Heat that is added to or removed from air without changing the air temperature

_______ g. An association that sets standards for motors and appliances

_______ h. The E.E.R. adjusted for seasonal usage

_______ i. Heat that is added to or removed from air causing a change in the air temperature

_______ j. An agency that tests air conditioners to assure they meet nationally recognized electrical safety requirements

_______ k. The introduction of outside air into a conditioned space or the exhausting of inside air to the outside

_______ l. A self-contained air conditioning device designed especially for installation in a window or wall opening to control temperature and humidity and manage the movement of conditioned air in a designated space

1. S.E.E.R.
2. Caulking
3. Ventilation
4. Sensible heat
5. A.H.A.M.
6. Window air conditioner
7. Latent heat
8. Air filter
9. N.E.M.A.
10. Condensation
11. U.L.
12. E.E.R.

2. Complete statements about objectives of window air conditioning. Write in the word(s) that best complete each of the following statements.

   a. Like any other cooling system, a window air conditioner lowers indoor air temperature by removing ______________ heat from room air.

Written Test

b. A WAC also removes ____________ heat from the air by removing ____________ which lowers ________________ and enhances the comfort level.

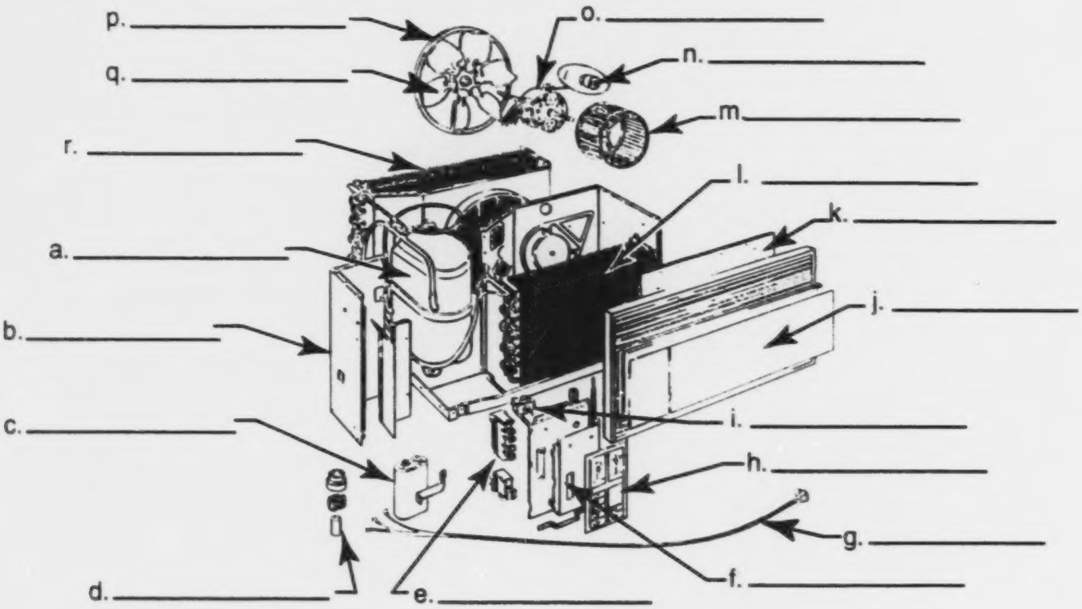
c. Some models also add heat to room air by using a ________________ cycle or with ________________ heating elements.

d. A WAC has a ________________ which stops particles in air from reentering a conditioned space.

e. A WAC circulates air in a conditioned space by using a ________________ set to a specific ________________ .

f. A WAC may also use ________________ to control ventilation, for bringing in fresh air, or for quickly exhausting odors or smoke.

3. Identify mechanical components of a window air conditioner. Place the number beside the component name in the lettered blank beside the component.

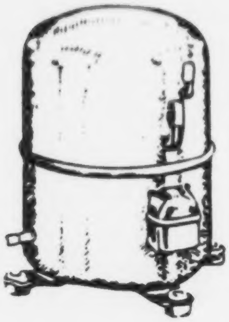


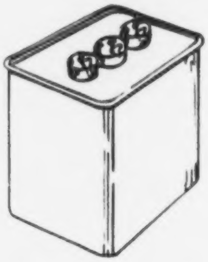
1. Slinger ring
2. Condenser fan
3. Condenser
4. Compressor
5. Divider
6. Dual capacitor
7. Blower motor
8. Motor mount grommets
9. Evaporator fan
10. Evaporator
11. Filter
12. Front grille
13. Control panel
14. Control panel escutcheon
15. Compressor mount
16. Control switch
17. Power supply cord
18. Thermostat

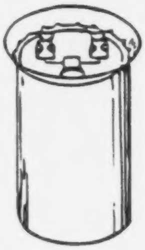
Written Test

4. Identify electrical components of a window air conditioner. Place the number beside the component name in the lettered blank beneath the component.

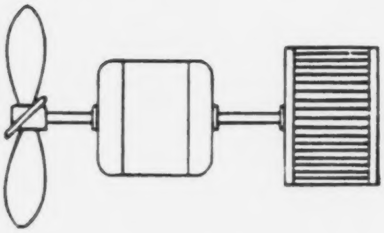
   1. Thermostat
   2. Fan motor
   3. Dual-run capacitor
   4. Start capacitor
   5. PSC compressor
   6. Control switch
   7. Potential relay

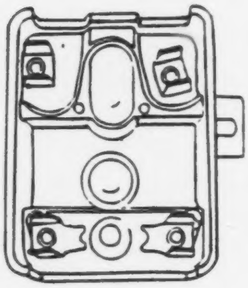


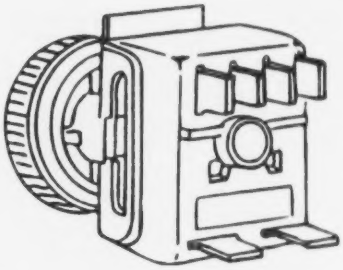




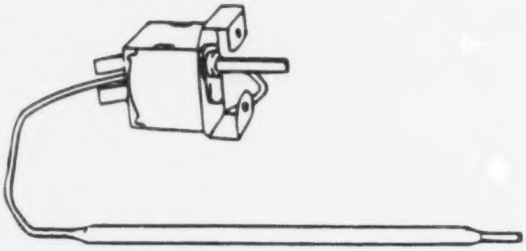
a. ____________________ b. ____________________ c. ____________________







d. ____________________ e. ____________________ f. ____________________

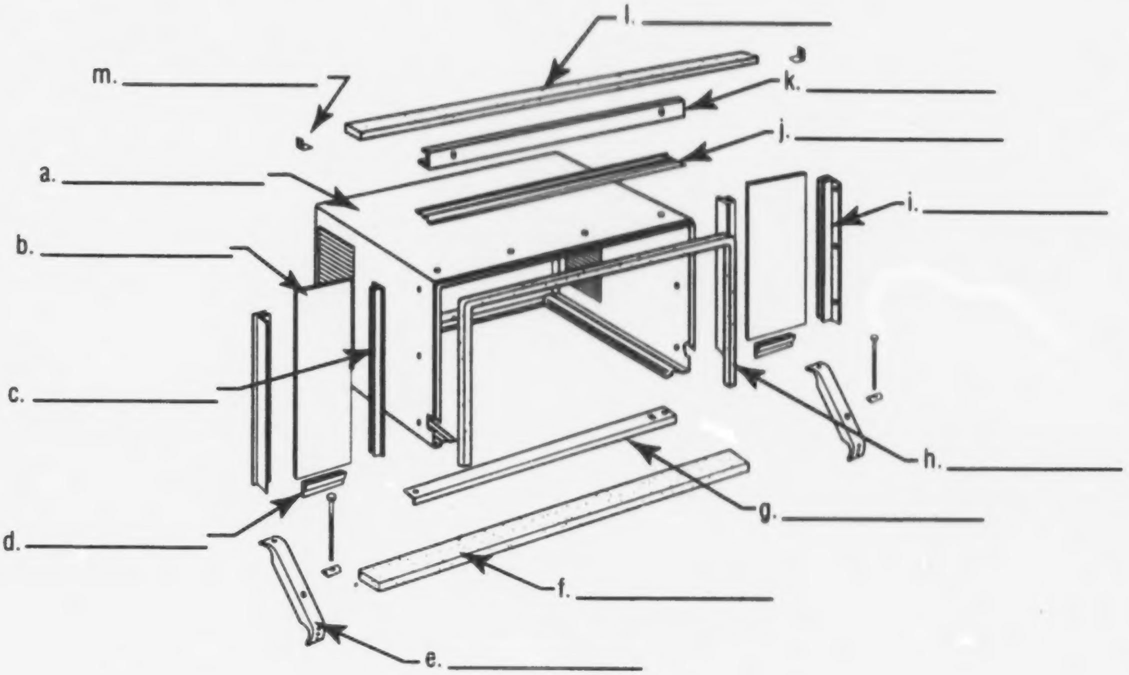


g. ____________________

Written Test

5. Identify window air conditioner cabinet parts. Place the number beside the name of the part in the blank beside its illustration.

   1. Sill seal
   2. Window seal
   3. Support bracket
   4. Sill channel
   5. Cabinet
   6. Side channel window
   7. Side channel cabinet
   8. Cabinet seal
   9. Seal bottom of side panel
   10. Sash lock bracket
   11. Sash angle
   12. Sash angle gasket
   13. Side panel



6. Complete statements about WAC data plates. Write in the word(s) that best completes each of the following statements.

   a. The information on a WAC data plate is important and can be useful when ________________ a unit.

Written Test

b. Information which should be on a data plate includes:

   1) ________________ name.

   2) ________________ number.

   3) serial number.

   4) type of ________________ .

   5) full load amperage (F.L.A.) or run load amperage (R.L.A.).

   6) locked rotor amperage (L.R.A.).

c. Information which may be on a data plate includes:

   1) E.E.R. or S.E.E.R. rating.

   2) stamp of a ________________ agency such as UL or NEMA.

   3) unit capacity expressed in ________________ .

7. Complete statements about compressor data plates. Write in the word(s) that best completes each of the following statements.

   a. The information on a compressor data plate can be very important if the unit data plate is missing or when ________________ the compressor.

   b. The data plate is usually located on the ________________ or on the ________________ of the compressor.

   c. Information which should be found on a compressor data plate includes:

      1) manufacturer.

      2) ________________ number.

      3) model number.

      4) serial number.

      5) electrical rating in volts, Hertz, and ________________ .

      6) L.R.A.

   d. Some compressor data plates include the ________________ .

Written Test

e. The ID number or other numbers may include encoded information that indicates:

   1) the ________________ and ________________ of manufacture.

   2) the ________________ where the compressor was made.

   3) what ________________ made the compressor.

f. ________________ information gives the manufacturer information about a compressor's history so that problems can be better identified and corrected.

g. The compressor is ________________ ________________ manufactured by the same company that manufactures the window air conditioner, so information on the compressor data pertains only to the compressor.

8. Solve problems about electrical requirements for WAC installations. Circle the number of the item that best completes each of the following problems.

   a. You are helping a coworker complete a WAC installation. You and your coworker have determined that the unit FLA rating is 20 amps. Before you install the unit you should:

      1) Make sure the power cord is not too short.

      2) Make sure the amperage of the unit does not exceed amperage at the receptacle.

      3) Check the building wiring and receptacle for the unit to make sure their rating is equal to or greater than the amperage specified on the unit.

   b. You are checking out a site for a WAC installation and you find a suitable 220V receptacle, but you find that another window air unit in an adjacent room is also on that circuit. You should:

      1) Inform the customer that the receptacle for each unit should be on a dedicated circuit.

      2) Suggest that the customer consider using a WAC unit with a lower amp rating.

      3) Remind the customer that the application is okay as long as both units are not "on" at the same time.

9. Select true statements about windows and other openings. Place an "X" beside each true statement.

_______ a. A WAC must be installed through an opening in a structure in order for it to be exposed to both indoor and outdoor conditions.

_______ b. As the name implies, WACs are usually installed in a window, but may be installed in a cased opening or an opening in glass or metal such as in a commercial building or motel.

_______ c. Both wood and metal windows are constructed with several parts that form a single unit that is installed in an opening in a wall.

_______ d. The moving part of a double-hung window is the sill which slides up and down in grooves in the casing.

_______ e. The casing is fastened to the structure to serve only as decoration.

_______ f. A frame may be added around the casing to cover gaps and provide additional stability.

_______ g. If the window has a sill, it will extend inside the structure and provide support for a window air conditioner.

_______ h. An opening in a structure designed especially for installation of a WAC will contain only a casing and is referred to as a "cased opening."

10. Solve problems about installing a window air conditioner. Circle the number of the item that best solves each of the following problems.

   a. A technician assigned the job of installing a window air conditioner at a residence arrives at the home and immediately unpacks the unit and starts installing side channels. The technician should have started by:

      1) having the customer check the unit to make sure it is the WAC that was ordered.

      2) checking for a proper sized receptacle on a properly sized dedicated circuit.

      3) checking for a solid sill so the cabinet can be securely attached.

   b. A technician installing a WAC into a metal window finds there is no sill, so the technician tries to fit the cabinet over the metal frame around the window. The technician should have:

      1) put some insulation in the metal frame for the cabinet to rest on.

      2) braced the cabinet with supports on either side inside the lip of the metal window.

      3) cut and installed a piece of wood such as a 1 x 2 or 2 x 4 to serve as a sill.

   c. A technician finished installing a WAC and checked it with a level; the unit checks out to be perfectly level. This means the technician should:

      1) make a test run to be sure the unit is operating properly.

      2) make adjustments so that the unit will tilt slightly toward the outside so condensate will not drip inside the conditioned space.

      3) inform the customer that the job is finished and the unit is ready for service.

Written Test

11. Complete statements about evaluating equipment condition. Write in the word(s) that best completes each of the following statements.

    a. A good ______________ inspection of the WAC will give you a great deal of information about how the WAC is operating.

    b. The important thing to check is ______________ because no WAC can operate properly with a dirty condenser or evaporator, and dirty coils may cause other components to malfunction.

    c. No WAC can operate properly without adequate ______________ ______________ through the evaporator and condenser coils, so grills and filters must be clean, and the unit must have adequate room for air circulation both inside and outside.

    d. If the WAC is not already running, start the unit and observe which components are functioning and how the unit ______________ .

    e. Observing means ______________ and ______________; can you hear the the fan? can you hear the compressor? can you see condensation or ice on the evaporator coil?

    f. If the unit runs, obtain and record operating ______________ and ______________, and remember, if the unit is dirty, clean it before taking any ______________ or ______________ readings.

12. Select true statements about investigating possible causes of problems. Place an "X" beside each true statement.

    ______ a. For a given complaint, there is eventually only one possible cause.

    ______ b. Experienced service technicians often have the cause of a complaint narrowed down to only two possible causes before they arrive on the service call.

    ______ c. An experienced service technician can rely on that experience to indicate the possible causes of a problem, but a beginner must use other technician's experiences which appear in the form of troubleshooting charts.

    ______ d. List possible causes of the complaint based on your deductions.

    ______ e. Additional observations or research may be necessary to evaluate all the information you have collected.

    ______ f. Remember, you must know what the unit IS doing and what it SHOULD or SHOULD NOT be doing in order to properly evaluate its condition.

13. Solve problems about determining actual causes of problems. Circle the number of the item that best solves each of the following problems.

    a. A technician servicing a window air conditioner finds the unit is plugged into a proper receptacle and assumes source voltage is available to the unit. There may be source voltage to the unit, but the technician can only verify source voltage by:

        1) checking to see that the main fuse is okay.

        2) asking the customer if the unit has been running.

        3) observing if any component operates; this definitely indicates source voltage is available.

    b. A technician on a service call makes four or five checks without stopping to evaluate each check. To avoid problems, the technician should:

        1) record all checks made so they can be evaluated later.

        2) make all checks again to assure they were made right the first time.

        3) know what each check means before making another check; accumulating information for the sake of accumulating information finds no causes.

14. Select true statements about servicing electrical components. Place an "X" beside each true statement.

_______ a. If preliminary observations indicate that some electrical component is not functioning or not functioning properly, check the component or circuit as required to determine the specific cause of the problem.

_______ b. If a check of a component indicates the component is faulty, repair or replace the component, and remember that it is usually easier to repair an electrical component than to replace it.

_______ c. Observe closely how the part to be removed is installed in the unit, and trust to your good memory to get it reinstalled properly.

_______ d. Be sure to check electrical components again after you have removed them to be certain that you have not misdiagnosed the problem..

_______ e. Sometimes the only required service is to clean the component thoroughly, recheck it, and reinstall it.

_______ f. Check carefully the specifications and/or part numbers of parts you remove, on the part itself or in manufacturer's literature, to be certain you select the proper replacement.

Written Test

15. Complete statements about replacing electrical components. Write in the word that best completes each of the following statements.

   a. When selecting replacement electrical components, consider:

      1) number of electrical ________________ switches have.

      2) position and action of switch ________________.

      3) types of mountings and ________________.

      4) types of wiring ________________.

      5) amperage ________________.

   b. When selecting replacement electrical components, also consider physical properties such as:

      1) physical ________________.

      2) motor shaft type, ________________, and length.

      3) direction of motor shaft ________________.

      4) motor ________________.

16. Solve problems about servicing refrigeration components. Circle the number in front of the item that best completes each of the following statements.

   a. On a service call, a technician has checked operating parameters of a WAC, and determined that the unit needs refrigerant. The technician should know what type and amount of refrigerant to put into the system, but should also know:

      1) that oil in the system also has to be changed.

      2) that troubleshooting should be completed before you start adding refrigerant.

      3) that a system needing refrigerant probably has a leak that needs to be located.

   b. A technician servicing a WAC discovers a very low refrigerant charge and carelessly vents the refrigerant to completely empty the system. The technician is:

      1) violating EPA regulations governing the venting of refrigerant into the atmosphere.

      2) failing to give the customer proper credit for what refrigerant might be left in the system.

      3) causing more problems by placing the system in a situation where it will have to be evacuated.

Written Test

17. Select true statements about safety while replacing refrigeration components. Place an "X" beside each true statement.

_______ a. Use proper procedures when replacing refrigeration components, or you may damage the part you are installing or other parts in the system.

_______ b. Use heat shields only as a last resort because they take time to install.

_______ c. Move wiring or other components out of the path of the torch flame or place protective heat shields between the components and the flame.

_______ d. When you use pliers, hammers, or other tools while removing components, work with care to avoid denting, bending, or otherwise damaging components that are going to be reused.

_______ e. When removing refrigeration components, you may have to choose between unsweating a connection and cutting.

_______ f. While unsweating connections preserves original length and shape, it presents the danger of overheating, and that is why cutting should always be used when removing refrigeration components.

18. Complete statements about servicing capillary tubes. Write in the word(s) that best completes each of the following statements.

a. Since cap tubes function in a fairly _______________ range of operating conditions, care must be taken in considering the many parameters that may affect cap tube operation.

b. Parameters that affect cap tube operation include:

1) length.

2) _______________ diameter.

3) capacity of _______________ motor.

4) type of _______________ .

5) type of evaporator.

6) type of condenser.

c. Cap tubes can be _______________ with any one of a variety of cap tube _______________ on the market; in all cases follow the cleaner manufacturer's directions.

d. If a cap tube is damaged or _______________ , you can sometimes replace a section of the cap tube.

Written Test

19. Complete statements about replacing compressors. Write in the information that best completes each of the following statements.

    a. After it has been determined that a hermetic compressor has failed either electrically or mechanically, the compressor must be ________________ .

    b. Remember that a compressor has both electrical and mechanical components and considerations for selecting replacement compressors should include:

        1) sizes and locations of ________________ ________________ connections.

        2) ________________ capacity of WAC.

        3) type of ________________, reciprocal, rotary, etc.

        4) type and amount of ________________ .

        5) type of ________________ in system.

        6) space available for refrigerant ________________ such as driers and accumulators.

    c. Be sure a replacement compressor is either an OEM replacement, or use a cross reference guide to select a compressor that is compatible with system ________________ ________________ .

    d. A condition known as burnout that often accompanies compressor ________________ failure requires special precautions while removing the burned out compressor and before installing a replacement.

    e. Anytime a system has been opened, a new ________________ ________________ ________________ must be installed, and a drier may need to be added to the suction line after a burnout.

    f. During a burnout, contaminants may be expelled into components on either side of the ________________, so take special care when you clean a system after a compressor burnout.

Permission to duplicate this test is granted.

Window Air Conditioner Service
Unit 6

Unit Evaluation Form

Student Name ____________________________________ Unit Rating ______________

Assignment Sheet 1—Use a Troubleshooting Guide to Find Causes of Customer Complaints Rating ________

Comments:

Job Sheet 1—Install a Window Air Conditioner Rating ________

Comments:

Job Sheet 2—Clean a Window Air Conditioner Rating ________

Comments:

Job Sheet 3—Replace a Fan Motor Rating ________

Comments:

Job Sheet 4—Install a Hard Start Kit Rating ________

Comments:

Job Sheet 5—Troubleshoot a Control Switch Rating ________

Comments:

Job Sheet 6—Replace a Liquid Line Filter-Drier Rating ________

Comments:

Job Sheet 7—Charge a Window Air Conditioner Using a Charging Cylinder Rating ________

Comments:

Job Sheet 8—Charge a Window Air Conditioner Using Charging Scales Rating ________

Comments:

Unit Evaluation Form

Job Sheet 9—Evaluate a Window Air Conditioner Charge	Rating ______
Comments:	
Job Sheet 10—Service a Capillary Tube	Rating ______
Comments:	
Job Sheet 11—Replace a Compressor	Rating ______
Comments:	
Other:	
Written Tests: ________ Pretest ________	Posttest ________
	Total ________
Teacher Signature ________________________	Date ____________
Student Signature ________________________	Date ____________

Permission to duplicate this form is granted.

361

Window Air Conditioner Service
Unit 6

Information Sheet

1. **Terms and definitions**

   a. **A.H.A.M. (Association of Home Appliance Manufacturers)**—An agency that certifies heating and cooling capacity ratings and electrical inputs of all air conditioners that bear the agency seal

   b. **Air filter**—A device for removing particles from air

   c. **Caulking**—A variety of putty-like compounds including silicon and acrylic products used to seal a joint and make it watertight

   d. **Condensation**—Water resulting from cooling moist air below its dew point

   e. **E.E.R. (Energy Efficiency Ratio)**—The ratio of energy consumed to energy produced which for air conditioners is determined by dividing the cooling capacity in BTUH by power input in watts

   f. **Latent heat**—Heat that is added to or removed from air without changing the air temperature

   g. **N.E.M.A. (National Electrical Manufacturer's Association)**—An association that sets standards for motors and appliances

   h. **S.E.E.R. (Seasonal Energy Efficiency Ratio)**—The E.E.R. adjusted for seasonal usage

   i. **Sensible heat**—Heat that is added to or removed from air causing a change in the air temperature

   j. **U.L. (Underwriter's Laboratories)**—An agency that tests air conditioners to assure they meet nationally recognized electrical safety requirements

   k. **Ventilation**—The introduction of outside air into a conditioned space or the exhausting of inside air to the outside

   l. **Window air conditioner (WAC)**—A self-contained air conditioning device designed especially for installation in a window or wall opening to control temperature and humidity and manage the movement of conditioned air in a designated space

   Note: Some OEMs refer to window air conditioners as "room air conditioners."

2. **Objectives of window air conditioning**

   a. Like any other cooling system, a window air conditioner lowers indoor air temperature by removing sensible heat from room air.

   b. A WAC also removes latent heat from the air by removing moisture which lowers humidity and enhances the comfort level.

Information Sheet

c. Some models also add heat to room air by using a heat pump cycle or with electrical heating elements.

d. A WAC has a filter which stops particles in air from reentering a conditioned space.

e. A WAC circulates air in a conditioned space by using a fan set to a specific RPM.

f. A WAC may also use dampers to control ventilation, for bringing in fresh air, or for quickly exhausting odors or smoke.

3. Mechanical components of a window air conditioner

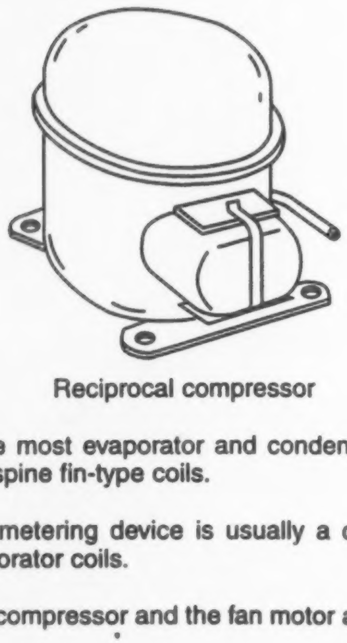
a. The components in a WAC are partitioned by a divider which separates the components exposed to indoor conditions from the components exposed to outdoor conditions.

b. WAC refrigeration components are the same as in any compression refrigeration cooling system.

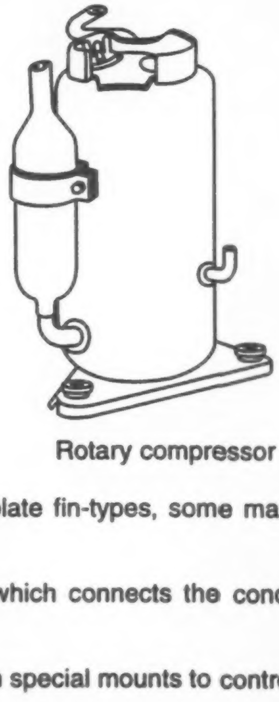
c. A fin-type evaporator is located in the indoor section in the air stream generated by the evaporator fan.

d. A hermetic reciprocal or rotary compressor and a fin-type condenser are located in the outdoor section in the air stream generated by the condenser fan.

e. Reciprocal and rotary compressors are easy to differentiate because rotary compressors are smaller, have a round shape, and usually have an accumulator fastened to one side.



Reciprocal compressor



Rotary compressor

f. While most evaporator and condenser coils are plate fin-types, some manufacturers use spine fin-type coils.

g. The metering device is usually a capillary tube which connects the condenser and evaporator coils.

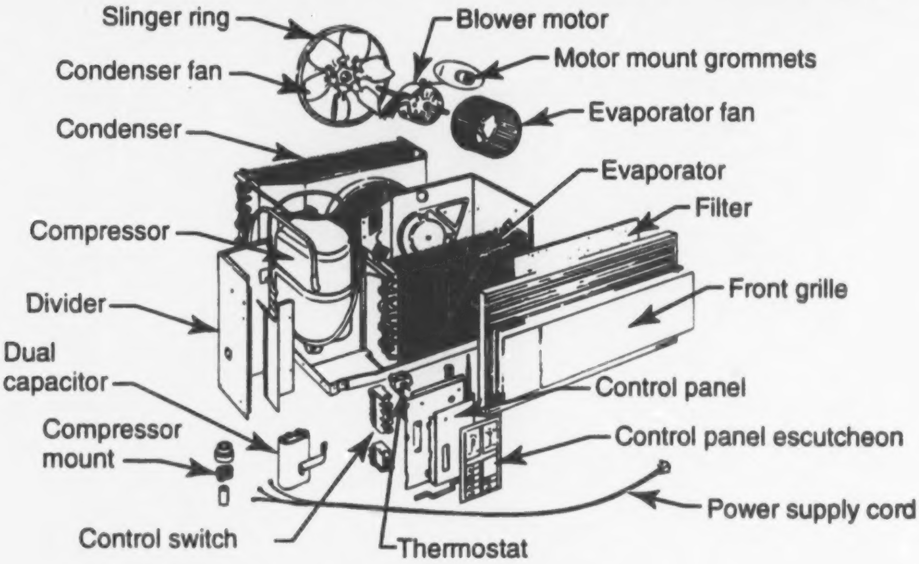
h. The compressor and the fan motor are mounted on special mounts to control vibration.

Information Sheet

i. The bladed or propeller-type condenser fan and the squirrel cage evaporator fan are turned by a shaft which extends out both ends of the fan motor.

j. A metal ring on the outer edge of some condenser fan blades, called a slinger ring, picks up condensate and sprays it across the condenser.

k. The filter in a WAC fits in the air stream ahead of the evaporator to keep dust, lint, and other particles from clogging the evaporator or reentering the conditioned space.


Slinger ring
Blower motor
Motor mount grommets
Condenser fan
Evaporator fan
Condenser
Evaporator
Filter
Compressor
Front grille
Divider
Dual capacitor
Control panel
Compressor mount
Control panel escutcheon
Power supply cord
Control switch
Thermostat

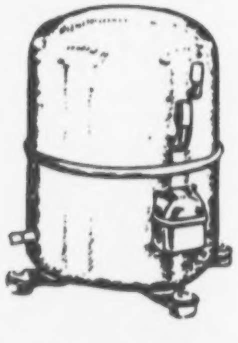
Typical Window Air Conditioner

l. The control panel escutcheon provides an eye-pleasing cover for the control panel which includes an on/off switch, a thermostat, and may include several other controls.

m. For cosmetic purposes, all or most of the front of a WAC unit will be covered by a grille.

4. **Electrical components of a window air conditioner**

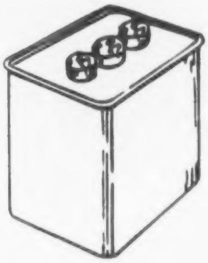
a. Window air conditioners use permanent split capacitor compressor motors which can usually be converted to capacitor start, capacitor run motors.



PSC Compressor

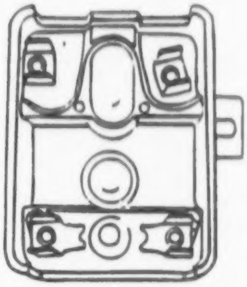
Information Sheet

b. A dual-run capacitor or two separate run capacitors assist both the compressor motor and the fan motor.

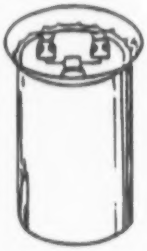


Dual-Run Capacitor

c. As determined by need, a window unit may require a hard start kit which includes a potential relay and a start capacitor.

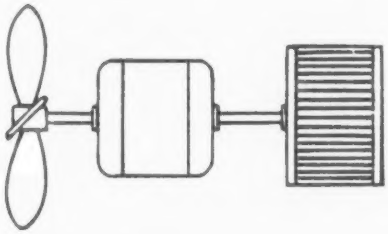


Potential Relay



Start Capacitor

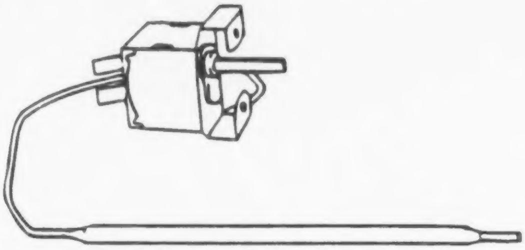
d. The double-shafted fan motor serves to operate both the squirrel-cage evaporator blower and the blade-type condenser fan and is usually a two- or three-speed motor.



Fan Motor

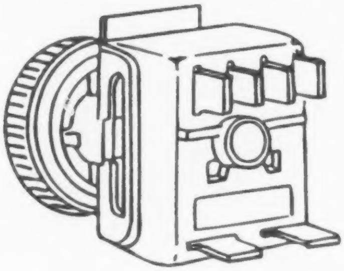
Information Sheet

e. The thermostat controls line voltage to cycle the compressor, and has an accessible front-panel control device.



Thermostat

f. The control switch provides on/off control for the entire system and has a high/low or sometimes more sophisticated fan selection switch.



Control Switch

g. Other controls may include a knob or lever to position dampers for ventilation or exhaust air, and/or a heat/cool switch if the unit is a heat pump type or has electric strip heating.

h. Some WAC models include an "air sweep" switch which controls a motorized damper which continually directs air from side to side.

i. Each WAC uses a power supply cord, rated to match the unit's amp draw to provide either 120V or 220V power.

Note: See Objective 8 and Student Supplement 1 for more power cord and receptacle information.

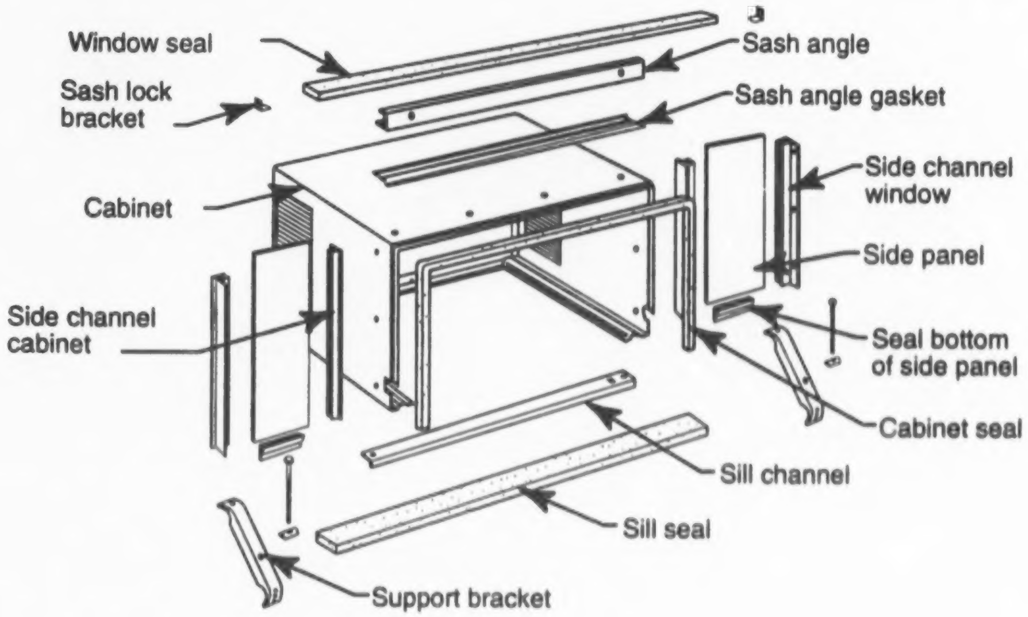
5. Window air conditioner cabinet parts

a. Window air conditioner cabinets are specifically designed to be fitted into a wooden or metal frame window or into a wall opening with support brackets or other devices to secure cabinets firmly to a structure.

b. The cabinet and cabinet seal fit into the opening and over a sill seal and sill at the bottom of the cabinet and under a window seal, a sash angle with a lock bracket, and a sash angle gasket at the top of the cabinet.

Information Sheet

c. Side channels fit against the window frame and against the cabinet wall, and work with a seal at the bottom of each side panel to house a side panel that fills the opening and can be modified to give the installation a really custom look.


Window seal
Sash angle
Sash lock bracket
Sash angle gasket
Side channel window
Cabinet
Side panel
Side channel cabinet
Seal bottom of side panel
Cabinet seal
Sill channel
Sill seal
Support bracket

Typical Window Air Conditioner Cabinet Parts

6. WAC data plates

a. The information on a WAC data plate is important and can be useful when servicing a unit.

b. Information which should be on a data plate includes:

   1) manufacturer's name.

   2) model number.

   3) serial number.

   4) type of refrigerant.

   5) full load amperage (F.L.A.) or run or rated load amperage (R.L.A.)

   6) locked rotor amperage (L.R.A.)

Information Sheet

c. Information which may be on a data plate includes:

   1) E.E.R. or S.E.E.R. rating.

   2) stamp of a certifying agency such as UL or NEMA.

   3) unit capacity expressed in BTUH.

7. Compressor data plates

a. The information on a compressor data plate can be very important if the unit data plate is missing or when replacing the compressor.

b. The data plate is usually located on the top or on the side of the compressor.

c. Information which should be found on a compressor data plate includes:

   1) manufacturer.

   2) identification number.

   3) model number.

   4) serial number.

   5) electrical rating in volts, Hertz, and phase.

   6) L.R.A.

d. Some compressor data plates include the F.L.A.

e. The ID number or other numbers may include encoded information that indicates:

   1) the month and year of manufacture.

   2) the plant where the compressor was made.

   3) what shift made the compressor.

f. Encoded information gives the manufacturer information about a compressor's history so that problems can be better identified and corrected.

g. The compressor is not usually manufactured by the same company that manufacturers the window air conditioner, so information on the compressor data plate pertains only to the compressor.

8. Electrical requirements for WAC installation

a. The unit power cord, the receptacle the cord plugs into, and the building wiring to the receptacle must all be rated equal to or greater than the FLA or RLA of the WAC.

b. The NEC, National Electric Code, rates AWG, American Wire Gauge, wire sizes according to the amperage the wire size is allowed to carry.

Information Sheet

c. AWG uses a system of numbers and letters to define current-carrying wires by mil size; letters are used to indicate the insulation type around the wire.

Example: A THW-10/3 AWG wire indicates a 10-gauge wire with three strands of wire encased in a heat and moisture resistant thermoplastic insulating cover.

d. AWG wire sizes and amperage ratings include:

  1) AWG 14 - 15 amp rating.
  2) AWG 12 - 20 amp rating.
  3) AWG 10 - 30 amp rating.
  4) AWG 8 - 40 amp rating.

e. Extra long cords or extension cords are not recommended because they reduce the current carrying capacity of the wire.

f. WAC receptacles should be on a dedicated circuit used for no other purposes.

g. Receptacles are designed for specific volt/amp requirements and should not be misapplied.

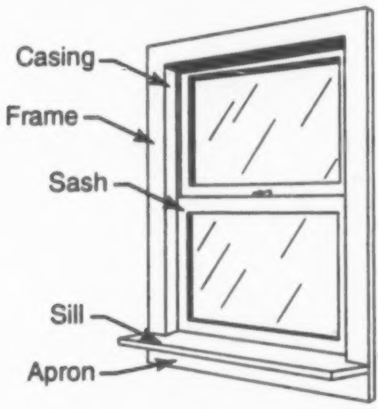
Note: See Student Supplement 1 for illustrations of types of WAC receptacles.

9. Windows and other openings

a. A WAC must be installed through an opening in a structure in order for it to be exposed to both indoor and outdoor conditions.

b. As the name implies, WACs are usually installed in a window, but may be installed in a cased opening or an opening in glass or metal such as in a commercial building or motel.

c. Both wood and metal windows are constructed with several parts that form a single unit that is installed in an opening in a wall.



Information Sheet

d. The moving part of a double-hung window is the sash which slides up and down in grooves in the casing.

e. The casing is fastened to the structure to hold the window in place.

f. A frame may be added around the casing to cover gaps and provide additional stability.

g. If the window has a sill, it will extend inside the structure and provide support for a window air conditioner.

h. An opening in a structure designed especially for installation of a WAC will contain only a casing and is referred to as a "cased opening."

10. Installing a window air conditioner

a. Before you start a WAC installation, make sure that there is a proper sized receptacle connected to a properly sized dedicated circuit available to power the unit.

b. Compare the WAC cabinet measurements with the size of the opening to make sure there is plenty of room for the unit.

c. Before beginning any WAC installation, read all of the installation instructions provided by the manufacturer, if they are available.

Note: If any of the following steps conflict with manufacturer's instructions, follow the OEM instructions.

d. Determine how much of the cabinet will extend into the room so you can determine where to attach side channels to the cabinet.

e. Attach other side channels to the casing, usually inside the grooves of the casing.

f. Attach the sill channel and seal to the window sill and attach the sash angle and gasket to the cabinet.

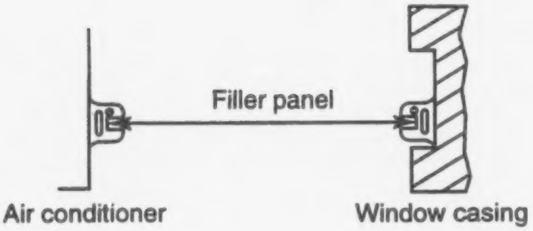
g. If there is no sill, as in a metal window, install a piece of wood such as a 1 x 2 or 2 x 4 to serve as a sill, if needed.

h. Center the cabinet in the opening and attach the cabinet to the sill channel.

i. If needed, attach support brackets to the bottom of the cabinet so that they are firmly braced against the outside wall.

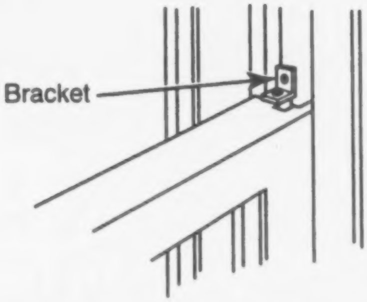
j. Cut filler panels approximately 1/8" smaller than the spaces on each side of the cabinet, fit seals onto the bottom of the panels, and slide panels into the side channels.

Information Sheet



Note: Some unit will have accordion pleated panels that adjust to fit different size openings.

k. Lower the sash to fit behind the sash angle, install sash lock brackets, and fasten sash angle to the sash.



l. Place window seal in place and install cabinet seal.

m. Use a level to make sure the cabinet tilts slightly towards the outside to prevent condensate water from dripping inside the structure.

n. Seal around the window or opening with caulking or weather stripping as needed.

o. Slide the unit into the cabinet and install the filter and front grille.

p. Plug the unit into the receptacle and check for proper operation.

11. **Evaluating equipment condition**

a. A good visual inspection of the WAC will give you a great deal of information about how the WAC is operating.

b. The important thing to check is cleanliness because no WAC can operate properly with a dirty condenser or evaporator, and dirty coils may cause other components to malfunction.

c. No WAC can operate properly without adequate air flow through the evaporator and condenser coils, so grilles and filters must be clean, and the unit must have adequate room for air circulation both inside and outside.

d. If the WAC is not already running, start the unit, try the controls in various positions, and observe which components are functioning and how the unit sounds.

Information Sheet

e. Observing means looking and listening; can you hear the fan? can you hear the compressor? can you see condensation or ice on the evaporator coil?

f. If the unit runs, obtain operating pressures and temperatures, and remember, if the unit is dirty, clean it before taking any pressure or temperature readings.

12. Investigating possible causes of problems

a. For a given complaint, there are a limited number of possible causes.

b. Experienced service technicians often have the cause of a complaint narrowed down to two or three, or sometimes only one, possible cause before they arrive on the service call.

c. An experienced service technician can rely on that experience to indicate the possible causes of a problem, but a beginner must use other technician's experiences which appear in the form of troubleshooting charts.

Note: See the troubleshooting chart in Student Supplement 2.

d. List possible causes of the complaint based on your dedications.

e. Additional observations or research may be necessary to evaluate all the information you have collected.

Note: Research may mean reading manufacturer's literature or other reference material, or talking to a supervisor or another technician who is more experienced.

f. Remember, you must know what the unit IS doing and what it SHOULD or SHOULD NOT be doing in order to properly evaluate unit condition.

13. Determining actual causes of problems

a. A service technician uses the process of elimination and checks of specific components to determine which of the causes listed during investigation is the actual cause of the problem.

Note: Typical causes and procedures are presented in Student Supplement 2.

b. Simple preliminary checks can eliminate many causes:

1) Make sure you have proper air flow before making any other checks.

2) If any component operates, source voltage is available.

3) If the compressor cycles when the thermostat setting is changed, the thermostat works and the compressor motor runs.

4) The evaporator fan motor should be running anytime the compressor is running.

5) Check motors with an ammeter so current can be compared to manufacturer's specifications.

c. If any of the components fail to operate, additional checks must be made with a voltmeter and/or the component has to be removed and checked with an ohmmeter.

d. If all components operate, but the proper temperatures are still not maintained, there may be a problem in the refrigeration cycle components.

e. Operating pressures must be compared with manufacturer's specifications, if available, or a typical superheat charging chart.

Note: Always attempt to locate manufacturer's specifications; use a typical superheat charging chart only as a last resort; see Job Sheet 9.

f. Abnormal operating conditions will indicate such problems as undercharge, overcharge, restriction, or compressor valve problems.

g. Abnormal noises, abnormal smells, oil spots, excessive temperature change at some point in a line, or improper frost patterns are good indicators of problem locations.

h. Observation of the rate of equalization of pressures after the compressor stops can be an indication of a restriction or compressor valve problem.

i. Never make another check until you know what the check you just made means; accumulating information for the sake of accumulating information finds no causes.

14. Servicing electrical components

a. If preliminary observations indicate that some electrical component is not functioning or not functioning properly, check the component or circuit as required to determine the specific cause of the problem.

b. If a check of a component indicates the component is faulty, repair or replace the component, and you will probably have to replace it because electrical components usually cannot be repaired.

c. Observe closely how the part to be removed is installed in the unit, and write down or sketch anything that might be useful during replacement.

d. Be sure to check electrical components again after you have removed them to be certain that you have not misdiagnosed the problem..

e. Sometimes the only required service is to clean the component thoroughly, recheck it, and reinstall it.

f. Check carefully the specifications and/or part numbers of parts you remove, on the part itself or in manufacturer's literature, to be certain you select the proper replacement.

15. Replacing electrical components

a. When selecting replacement electrical components, consider electrical parameters such as:

1) number of electrical poles switches have.

2) position and action of switch contacts.

3) types of mountings and fasteners.

4) types of wiring connections.

5) amperage ratings.

b. When selecting replacement electrical components, also consider physical properties such as:

1) physical dimensions.

2) motor shaft type, diameter, and length.

3) direction of motor shaft rotation.

4) motor horsepower.

Note: Use OEM replacement when available.

16. Servicing refrigeration components

a. If operating parameters indicate that a component is not operating properly, the component almost always has to be replaced.

b. Remember, the refrigerant from any appliance must be removed according to EPA regulations before dismantling the refrigeration system.

c. Observe closely how components are installed in the system and note anything that would be helpful during replacement.

d. Check carefully the specifications and/or part numbers of parts removed, on the part itself or in manufacturer's literature so that you can select the proper replacement.

e. Be sure to check direction of flow through refrigeration components to assure that directionally-oriented components are properly installed.

f. If operating parameters indicate that the system needs refrigerant, it can be assumed that the system leaks.

g. A system should be checked for leaks anytime a leak is suspected or anytime refrigeration components are added or replaced.

h. Anytime oil is lost or removed from the refrigeration system, the same amount and type of refrigerant oil must be added to the system.

Note: New compressors may come with an oil charge or come with specifications for the amount and type of acceptable alternative oils.

17. Safety while replacing refrigeration components

a. If you do not use proper procedures when replacing refrigeration components, you may damage the part you are installing or other parts in the system.

Information Sheet

b. Use heat shields or heat-absorbing materials to protect heat-sensitive components or adjacent components when using a torch.

c. Move wiring or other components out of the path of the torch flame or place protective heat shields between the components and the flame.

d. When you use pliers, hammers, or other tools while removing components, work with care to avoid denting, bending, or otherwise damaging components that are going to be reused.

e. When removing refrigeration components, you may have to choose between unsweating a connection or cutting, and you should consider both potential system dangers and replacement costs when deciding which method to use.

f. While unsweating connections preserves original length and shape, it presents the danger of overheating, and while cutting eliminates the danger of overheating, it may add the expense of extra parts to make things fit properly.

18. Servicing capillary tubes

a. Since cap tubes function in a fairly narrow range of operating conditions, care must be taken in considering the many parameters that may affect cap tube operation.

b. Parameters that affect cap tube operation include:

1) length.

2) inside diameter.

3) capacity of compressor motor.

4) type of refrigerant.

5) type of evaporator.

6) type of condenser.

c. Cap tubes can be cleaned with any one of a variety of cap tube cleaners on the market; in all cases follow the cleaner manufacturer's directions.

d. If a cap tube is damaged or restricted, you can sometimes replace a section of the cap tube.

Note: See Job Sheet 10.

19. Replacing compressors

a. After it has been determined that a hermetic compressor has failed either electrically or mechanically, the compressor must be replaced.

Note: Many compressors returned to manufacturers have nothing wrong with them; be sure to double check a compressor before you remove and return it!

Information Sheet

b. Remember that a compressor has both electrical and mechanical components and considerations for selecting replacement compressors should include:

   1) sizes and locations of refrigerant line connections.

   2) Btuh capacity of WAC.

   3) type of compressor, reciprocal, rotary, etc.

   4) type and amount of refrigerant.

   5) type of oil in system.

   6) space available for refrigerant accessories such as driers and accumulators.

c. Be sure a replacement compressor is either an OEM replacement, or use a cross reference guide to select a compressor that is compatible with system operating parameters.

d. A condition known as burnout that often accompanies compressor electrical failure requires special precautions while removing the burned out compressor and before installing a replacement.

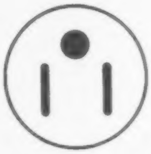
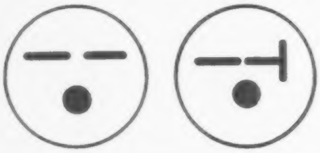
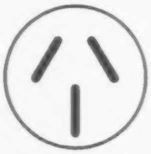
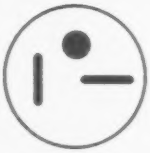
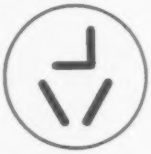
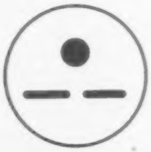
   Note: See Job Sheet 11.

e. Anytime a system has been opened, a new liquid line drier must be installed, and a drier may need to be added to the suction line after a burnout.

f. During a burnout, contaminants may be expelled into components on either side of the compressor, so take special care when you clean a system after a compressor burnout.

Window Air Conditioner Service
Unit 6

Student Supplement 1—Receptacle Design

Receptacle Design	Voltage Limit	Amperage Limit
	115 Volts	15 Amps
	230 Volts	15 Amps
	230/208 Volts	20 Amps
	230/208 Volts	20 Amps
	230/208 Volts	30 Amps
	230/208 Volts	30 Amps

Window Air Conditioner Service
Unit 6

Student Supplement 2—Window Air Conditioner Troubleshooting Guide

Symptoms and Possible Causes	Troubleshooting Procedures
1. Nothing runs	
a. No source voltage	Check source voltage (none) Replace fuse or reset breaker Check source voltage (none or more than 10% below rating Ask user to call electrician (If breaker trips again or fuse blows immediately, some component is grounded or a direct short exists) Check major components until fault is found
b. Broken cord	Check source voltage (present) Check voltage where cord connects to unit (none) Replace cord
2. Fan runs; compressor does not run	
a. Thermostat or selector switch(es) not properly set	Set switch(es) to call for cool and turn thermostat to coldest setting (Compressor runs and evaporator coil temperature drops after a few minutes of operation) Inform user and suggest checking operating instructions for proper control settings Set control(s) for desired operation and offer to show user how
b. Broken selector switch	See 2a (compressor does not run) Check for voltage with leads at other leg of power and at each side of the switch (Voltage present at inlet, but not present at outlet) Jumper switch (compressor starts) Replace switch
c. Broken thermostat	Turn thermostat to coldest setting (compressor does not run) Jumper across terminals (compressor runs and evaporator coil temperature drops after a few minutes of operation) Replace thermostat
d. Wires loose or broken	See 2c (compressor does not run after terminal jumped) Check connections at controls and at compressor (loose or broken) Repair or replace wires
e. Broken run capacitor	See 2d (wiring okay when checked) Check run capacitor appearance (may be swollen) Check voltage with leads at capacitor inlet and at common on compressor (voltage present) Check voltage with leads at start and common terminals on compressor (voltage not present; capacitor open) Replace capacitor (Voltage present at start and common) Remove capacitor and check it with a capacitor analyzer (capacitor shorted or not producing rated mfd) Replace capacitor
f. Broken start capacitor	See 2e (run capacitor okay) Check start capacitor appearance (may be discolored, oily, or cracked) Remove capacitor and check with an ohmmeter or capacitor analyzer (open, shorted, or weak) Replace start capacitor
g. Broken potential relay	See 2f (start capacitor checks okay) Remove relay and check with an ohmmeter or component analyzer (open coil or open or stuck contacts) Replace relay

Student Supplement 1

Symptoms and Possible Causes	
2. (Continued)	
h. Broken external overload	See 2g (relay checks okay) Check voltage with leads at incoming side of overload and at run terminal on compressor (source voltage available) Check voltage with leads at common and run terminals on compressor (no source voltage available) Remove overload and check with ohmmeter (open) **Caution:** Verify that overload is not overheated Replace overload
i. Broken compressor (electrical problem)	See 2h (overload checks okay) Feel compressor (not hot or warm to touch) Isolate terminals from system wiring and check compressor motor (open, shorted, or grounded) **Caution:** Verify that internal overload has had sufficient time to cool; this may take several hours) Replace compressor
j. Restriction in refrigerant line	Feel compressor (warm or hot to touch) See 2i (compressor motor does not check open, shorted, or grounded) Hook compressor motor to test cord or hermetic analyzer and compare amperage to locked rotor rating (above rating) Install suction valve, if not provided, and check suction pressure (much too low) Install discharge valve, if not provided, and check discharge pressure (much too high) Recover refrigerant and attempt to start the compressor (compressor starts) Locate restriction, repair, replace liquidl line drier, evacuate, and recharge with refrigerant
k. Broken compressor (stuck)	See 2j (no restriction found) Use a test cord or hermetic analyzer to momentarily apply a larger than normal start capacitor to attempt to start the motor (motor fails to start) Use a test cord or hermetic analyzer to momentarily reverse the motor and attempt to start again (fails to start) Use a test cord to apply higher than normal voltage (fails to start) Replace compressor
3. Compressor runs; fan does not run	
a. Broken fan selector switch	Select fan switch position (fan motor does not run) Jumper switch (fan motor runs) Replace fan selector switch
b. Fan or blower wheel binding	Check movement of condenser fan and evaporator blower (will not turn or rubs on something when turned) Check for foreign objects such as insect or rodent nests and clear as necessary Check for alignment of fan and blower (binding against other components) Realign or replace as necessary
c. Broken run capacitor	Check capacitor appearance (may be swollen) Check voltage with leads at capacitor inlet and at common lead on fan motor (voltage not present, capacitor open) Replace capacitor (Voltage present) Remove capacitor and check it with an ohmmeter or a capacitor analyzer (capacitor shorted or not producing rated mfd) Replace capacitor

Student Supplement 1

Symptoms and Possible Causes	Troubleshooting Procedures
3. (Continued)	
d. Broken fan motor	See 3c (capacitor checks okay) Check voltage at motor leads (proper voltage present) Remove fan motor and check (open, shorted, grounded, or bearings worn out) Replace motor
e. Loose or broken wiring in fan motor circuit	See 3d (no voltage at motor leads) Check wires and connections to the fan motor (loose or broken) Repair or replace wiring
4. Fan motor runs; compressor runs continuously and unit not cooling properly	
a. Blocked or dirty condenser	Observe condition of both sides of condenser (dirty or blocked) Clean condenser and remove obstructions **Note:** When the condenser is dirty, the evaporator is usually dirty too, and the first step when servicing a unit in this condition is to remove the unit and take it somewhere, like a carwash, for cleaning
b. Blocked or dirty evaporator	Remove front grille and filter and observe condition of the grille, filter, and evaporator (dirty or blocked) Clean evaporator and remove obstructions See note in 4a **Note:** If evaporator is iced over, it must be thawed out before cleaning
c. Outside air intake open	Check position of outside air intake damper (open) Check position of damper control (set for open) Turn control to close damper (Damper control set for closed, but damper is open) Check for problems with damper mechanism (disconnected or broken) Repair as needed
d. Improper refrigerant charge	Check operating pressures and temperatures by attaching a refrigeration gauge set and installing access valves if needed (both pressures too low; evaporator may be iced over) Check for leaks, repair as needed, and use proper procedures to adjust charge (Both pressures too high) Adjust refrigerant charge to proper pressures and temperatures
e. Compressor valves not holding	See 4d (low pressure too high and high pressure too low) Replace compressor or WAC
f. WAC improperly applied	Check temperature drop of air across the evaporator coil (too small) Compare capacity of WAC with cooling requirements of space to be conditioned (WAC does not have enough capacity) Check distance to wall or other obstructions in path of supply air flow (too close) Inform user
5. Fan motor runs; compressor motor short cycles	
a. Dirty or blocked condenser	Check air flow across condenser (not enough) Clean condenser or correct as necessary
b. Thermostat sensor improperly located	Observe position of thermostat sensor (out of position or something blocking air flow across sensor) Replace sensor or remove blockage
c. Broken thermostat	Immerse thermostat sensor in ice water and observe operating temperatures (cuts on and off at wrong temperatures) Replace thermostat
d. Low voltage to WAC	Check voltage at receptacle or power supply (too low) Call electrician and/or inform user

Student Supplement 1

Symptoms and Possible Causes	Troubleshooting Procedures
5. (Continued)	
e. Broken external overload	Check voltage with leads at incoming side of overload and at run terminal on compressor (source voltage available and continuous) Check voltage with leads at common and run terminals on compressor (voltage cycles) Check running amperage and shell temperature of compressor (normal) Replace overload
f. Shorted run capacitor	See 5e (running amperage and/or shell temperature above normal) Remove capacitor and check with an ohmmeter or capacitor analyzer (shorted) Replace capacitor
g. Loose wiring connections	See 5f (capacitor checks okay) Feel wires going to the compressor (one or more wires warm to the touch) Repair or replace wires (Wires not warm to the touch) Check all wiring connections (some loose or broken) Repair or replace

Window Air Conditioner Service
Unit 6

Assignment Sheet 1—Use a Troubleshooting Guide to Find Causes of Customer Complaints

Name ____ Overall Rating ______________

Evaluation Criteria	**Rating**
Number of causes listed	______
Number of correct causes listed	______

Directions: Read the following service scenarios carefully, and after consulting the Troubleshooting Guide in Student Supplement 2, list possible causes of the customer complaints or describe what the service technician should do.

Example Scenario:

The service work order states that the customer's window air conditioner will not run at all. Upon arrival at the location, you turn the selector switch to cool and the thermostat to its coldest setting and nothing happens.

Procedure: Go to the troubleshooting guide and find the symptom that matches the customer complaint. In this example, the symptom is Item 1, "Nothing runs." Below the symptom is a list of possible causes. Use the checks that you made to identify which of the listed causes are possible causes of the problem with the WAC. In this example, neither of the listed causes can be eliminated by your checks, so list both causes.

1. No source voltage (blown fuse or tripped breaker would also be acceptable).
2. Broken cord.

Follow up: Once you have listed possible causes, follow the steps in the Troubleshooting Procedures column to identify the specific cause of the problem. Information in parentheses shows what results you will get from a check if the listed cause is the problem. Any result other than that shown in parentheses means that the cause listed is not the real cause of the problem. This process of elimination is what troubleshooting is all about.

Scenario A: The service work order states that a customer complains that the customer's WAC is running, but not cooling. Upon arrival at the location, you hear the sound of a fan running and feel approximately room temperature air blowing out the front of the unit. You remove the front of the WAC and observe a reasonably clean filter and evaporator coil. You make sure the selector switch is set for cooling and the thermostat is turned to its coldest setting. You do not hear the compressor running. You take the control panel loose, and jumper the thermostat. You hear the compressor start.

1. ____

Assignment Sheet 1

Scenario B: The service work order states that a customer complains that the WAC is running, but not cooling. Upon arrival at the location, you hear the sound of a fan running and feel approximately room temperature air blowing out the front of the unit. You remove the front of the WAC and observe a reasonably clean filter and evaporator coil. You make sure the selector switch is set for cooling and the thermostat is turned to its coldest setting. You do not hear the compressor running. You take the control panel loose, and jumper the thermostat. You do not hear the compressor start. You check for voltage where the compressor leads hook onto the control panel and find source voltage available. You observe no starting components on the unit.

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

Scenario C: The service work order states that the customer complains that the WAC makes noise, but no air is blowing out. Upon arrival at the location, you set the selector switch for fan operation and turn the thermostat to its warmest position. You hear no fan running and feel no air blowing. You take the control panel loose and jumper the fan switch. The fan motor does not start.

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________

Scenario D: The service work order states that the customer complains that the WAC runs but does not cool. Upon arrival at the location, you make sure the selector switch is calling for cooling and the thermostat is turned to its coldest setting. You hear the fan motor and compressor motor running and feel slightly cooler than room-temperature air blowing out the front of the unit. You remove the front and observe that the filter and evaporator coil are reasonably clean. You go outside and observe that the condenser coil is reasonably clean.

1. ______________________________
2. ______________________________
3. ______________________________

Assignment Sheet 1

Scenario E: The service work order states that the customer complains that the WAC runs but does not cool, and there is a sound of something starting and stopping. Upon arrival at the location, you make sure the selector switch is calling for cooling and the thermostat is set to its coldest setting. You hear the fan motor blowing and what sounds like the compressor starting and stopping every few seconds. You feel slightly cooler than room-temperature air blowing out the front of the unit. You check voltage at the WAC receptacle and find it adequate. You remove the front of the unit and see that the filter and evaporator coil are reasonably clean, and that the thermostat sensor appears to be properly located. What should your next step be?

1. ______________________________

____

Window Air Conditioner Service
Unit 6

Job Sheet 1—Install a Window Air Conditioner

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	Rating
Cabinet properly installed	______
Backward tilt of cabinet at proper angle	______
Outside area of cabinet sealed	______
WAC unit verified operational	______

A. Tools and materials

Window air conditioner as selected by instructor
Refrigeration technician's hand tools
Caulking gun and caulking compound
Level
Hand saw
Clean shop cloths
Safety glasses

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Carefully uncrate the window air conditioning unit.

☐ 3. Remove and read the manufacturer's installation and operating instructions that come with the unit, and make sure you have the proper receptacle near the installation point.

☐ 4. Remove shipping bolts and brackets.

☐ 5. Slide the air conditioning unit out of the cabinet.

☐ 6. Locate the window where the WAC will be installed.

☐ 7. Attach the side channels to the window casing.

☐ 8. Attach the side channels to the cabinet.

Job Sheet 1

☐ 9. Attach the sill panel and seal to the window sill.

☐ 10. Attach the sash angle and gasket to the cabinet.

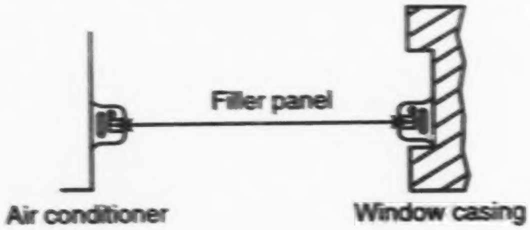
☐ 11. Measure to determine the center of the window sill.

☐ 12. Place the cabinet in the center of the window.

☐ 13. Attach the cabinet to the sill channel.

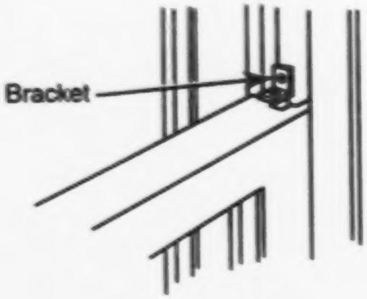
☐ 14. Attach the support brackets to cabinet.

☐ 15. Measure and cut the filler panels 1/8 inch smaller than the filler space.



☐ 16. Slide the side panels into the channels, place the bottom seals in place, and fit the panels into place.

☐ 17. Lower the window sash and install the sash lock brackets.



☐ 18. Fasten the cabinet sash angle to the sash.

☐ 19. Place the window seal in place.

Job Sheet 1

☐ 20. Slide air conditioner into cabinet.

☐ 21. Install cabinet seal.

☐ 22. Use a level to check for proper cabinet tilt; 1/4 of a bubble on the level indicates a good tilt angle.

☐ 23. Caulk around the outside of the window.

☐ 24. Install the front grille.

☐ 25. Plug in the air conditioner and turn it on.

☐ 26. Allow the unit to run long enough to verify proper operation, and record operating temperatures.

☐ 27. Complete the Service Work Order that accompanies this job sheet.

☐ 28. Have your instructor check your work.

☐ 29. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ____

____

____

Job Sheet 1

Service Work Order

Customer's Name ____________________

Customer's Address ____________________

Brief description of problem ____________________

____

____

Time and date service or repair started ____________________

Time and date service or repair ended ____________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ____________________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ____________________

What amount of refrigerant was added? ____________________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type?__________ Amount? ______

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ____________________ Date ____________

Job Sheet 1

Service Work Order

Evaluation of unit condition and general performance:

____

____

____

____

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressure after pressures have stabilized			
e. Liquid line pressure after pressures have stabilized			
f. Evaporator air temperature	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
g. Condenser air temperature	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
h. Additional information			
i. Additional information			
j. Technician's signature ____________________ Date __________			

Window Air Conditioner Service
Unit 6

Job Sheet 2—Clean a Window Air Conditioner

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	Rating
Motor properly wrapped in plastic bag	______
Proper cleaning solution used on condenser and evaporator	______
Components properly dried after cleaning	______
Window unit verified operational	______

A. Tools and materials

Window air conditioner as selected by instructor
Refrigeration technician's hand tools
Plastic bag
Water hose
Spray nozzle for water hose
Cleaning solution or coil cleaner (or both)
Rubber gloves
Safety glasses

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Ask a co-worker to help you remove the air conditioning unit from the cabinet.

☐ 3. Set the air conditioner near a floor drain or place it in an outside area where you can spray water on it.

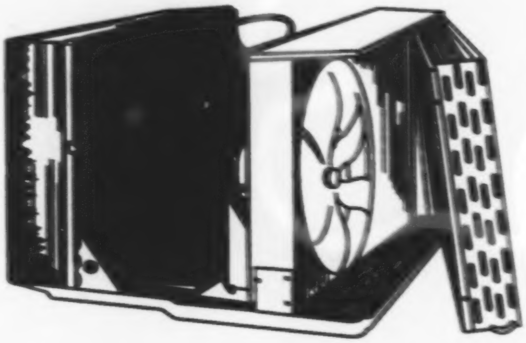
Note: This is often accomplished by taking the unit to a car wash.

☐ 4. Place a plastic bag around the fan motor and tape it securely in place.

☐ 5. Remove the screws that hold the condenser to the fan shroud.

Job Sheet 2

☐ 6. Carefully swing the condenser away from the unit, but be careful not to kink or break refrigerant lines.



☐ 7. Spray cleaning solution on the condenser and on the evaporator.

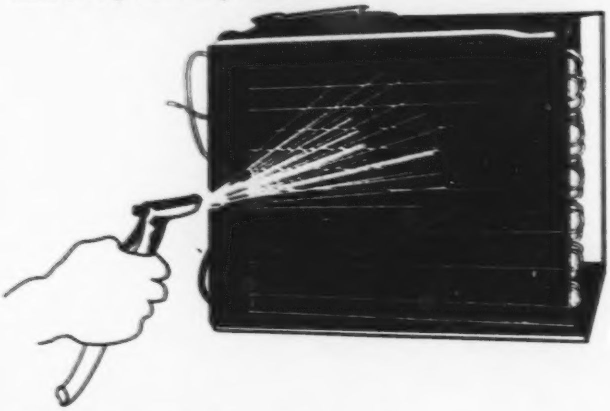
☐ 8. Allow the cleaning solution time to work, and follow all cleaning directions.

☐ 9. Attach the water hose to a water supply.

☐ 10. Put the spray nozzle on the water hose and turn the water on.

☐ 11. Spray the condenser and evaporator with water.

Note: Be careful with the fins on spine-fin coils like the ones used on some GE units; they are easy to bend.



☐ 12. Clean the evaporator drain tubes.

☐ 13. Clean the entire drain pan.

☐ 14. Tilt the unit sideways so water will drain out.

☐ 15. Remove water in the squirrel cage housing.

Job Sheet 2

☐ 16. Check the entire unit to be sure all water has been drained.

☐ 17. Remove the plastic bag from the motor.

☐ 18. Dry all electrical components with a clean shop cloth, or allow time for air drying.

☐ 19. Carefully move the condenser back into position and secure it to the shroud.

☐ 20. Have your instructor check your work.

☐ 21. Get a coworker to help you place the window air conditioner unit back into the cabinet.

☐ 22. Plug the unit in and turn it on.

☐ 23. Allow the unit to run long enough to verify proper operation, and record operating temperatures.

☐ 24. Complete the Service Work Order that accompanies this job sheet.

☐ 25. Have your instructor check your results.

☐ 26. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

____

____

Job Sheet 2

Service Work Order

Customer's Name ____________________

Customer's Address ____________________

Brief description of problem ____________________

____

____

Time and date service or repair started ____________________

Time and date service or repair ended ____________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ____________________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ____________________

What amount of refrigerant was added? ____________________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type?________ Amount? ______

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ____________________ Date ____________

Job Sheet 2

Service Work Order

Evaluation of unit condition and general performance:

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressure after pressures have stabilized			
e. Liquid line pressure after pressures have stabilized			
f. Evaporator air temperature	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
g. Condenser air temperature	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
h. Additional information			
i. Additional information			

j. Technician's signature ______________________ Date ____________

Window Air Conditioner Service
Unit 6

Job Sheet 3—Replace a Fan Motor

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
Old fan motor properly removed	______
Fan motor shaft properly sanded	______
New motor properly installed	______
New capacitor properly installed	______
Window unit verified operational	______

A. Tools and materials

Window air conditioner as selected by instructor
Refrigeration technician's hand tools
Replacement fan motor as selected by instructor
New capacitor
Hacksaw
Sand cloth
Safety glasses

B. Procedure

☐ 1. Put on safety glasses.

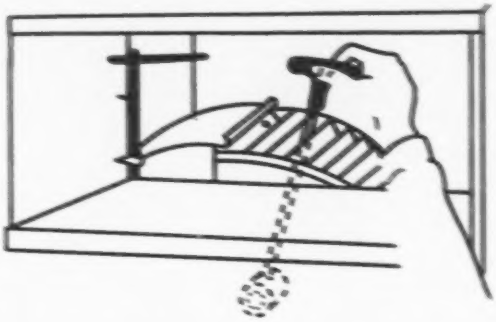
☐ 2. Get a coworker to help you remove the air conditioner unit form the cabinet.

☐ 3. Set the unit in an area where you can work unobstructed.

☐ 4. Remove panels as required to provide access to fan hub.

Job Sheet 3

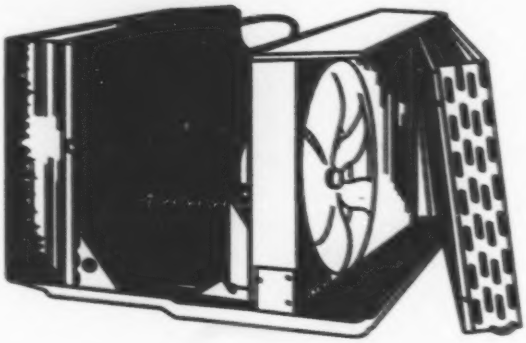
☐ 5. Loosen the set screw in the evaporator fan hub.



☐ 6. Remove the motor wires from the control switch, and note what wires are hooked to what terminals so you can reinstall them properly.

☐ 7. Remove the screws which hold the condenser to the fan shroud.

☐ 8. Carefully swing the condenser away from the fan, being careful not to kink or break refrigerant lines.



☐ 9. Remove the set screw from the condenser fan hub.

☐ 10. Clean the condenser fan motor shaft with sand cloth.

Note: This sometimes requires sliding the condenser fan towards the motor.

☐ 11. Slide the condenser fan off the motor shaft.

☐ 12. Remove the bolts that hold the fan motor cradle or other mounts to the air conditioner.

Job Sheet 3

☐ 13. Remove the motor and cradle by sliding the front shaft out of the evaporator blower wheel.

Note: It sometimes helps to hold the shaft with a wrench and turning the blower wheel back and forth while sliding the shaft out.

☐ 14. Check the direction of rotation.

☐ 15. Check for proper shaft length on the new motor.

Note: If the shaft is too long for the new motor, cut it with a hacksaw, but before you cut the shaft, be sure about the direction of rotation.

☐ 16. Remove the old motor from the cradle.

☐ 17. Lubricate the motor shaft.

☐ 18. Place the new motor in the cradle.

☐ 19. Align the motor shaft with and slide it into the evaporator blower hub.

☐ 20. Replace the fan motor cradle or mounting bolts.

☐ 21. Slide the condenser fan onto the shaft.

☐ 22. Check to make sure that the fan blades are aligned properly and do not hit the shroud.

☐ 23. Tighten the fan set screws against the flat place on the shaft.

☐ 24. Remove the wires to the old capacitor and then remove the old capacitor.

☐ 25. Install the new capacitor and put the wires back into place.

☐ 26. Put the condenser back into position.

☐ 27. Replace the screws that hold the condenser to the shroud.

☐ 28. Connect wires to the control switch.

☐ 29. Turn the fan by hand to be sure that the blades and blower wheel are running clear of the shrouds.

☐ 30. Have your instructor check your work.

☐ 31. Have a coworker help you replace the air conditioner unit into the cabinet.

☐ 32. Check the fan motor operation and amperage.

Job Sheet 3

☐ 33. Allow unit to run long enough to verify proper operation, and record operating temperatures.

☐ 34. Have your instructor check your work again.

☐ 35. Complete the Service Work Order that accompanies this job sheet.

☐ 36. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

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ACRD-295

Job Sheet 3

Service Work Order

Customer's Name ______________________________

Customer's Address ______________________________

Brief description of problem ______________________________

____

____

Time and date service or repair started ______________________________

Time and date service or repair ended ______________________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ______________________________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ______________________________

What amount of refrigerant was added? ______________________________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type? __________ Amount? __________

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ______________________________ Date ______________

Job Sheet 3

Service Work Order

Evaluation of unit condition and general performance:

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressure after pressures have stabilized			
e. Liquid line pressure after pressures have stabilized			
f. Evaporator air temperature	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
g. Condenser air temperature	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
h. Additional information			
i. Additional information			
j. Technician's signature ______ 400 ______ Date ______			

Window Air Conditioner Service
Unit 6

Job Sheet 4—Install a Hard Start Kit

Name ______________________ Attempt Number ________

Date ______________________ Overall Rating ________

Evaluation Criteria	**Rating**
Hard start kit installed to specifications	______
Components properly wired	______
Running amperage checked	______
Window unit verified operational	______

A. Tools and materials

Window air conditioner as selected by instructor
Refrigeration technician's hand tools
Start capacitor with bleed resistor
Potential relay
14-gauge stranded wire
Wire connectors
Side cutters and crimping tool
Ammeter
Ohmmeter
Safety glasses

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Have a coworker help you remove the air conditioning unit from the cabinet.

☐ 3. Set the unit in a place where you can work unobstructed.

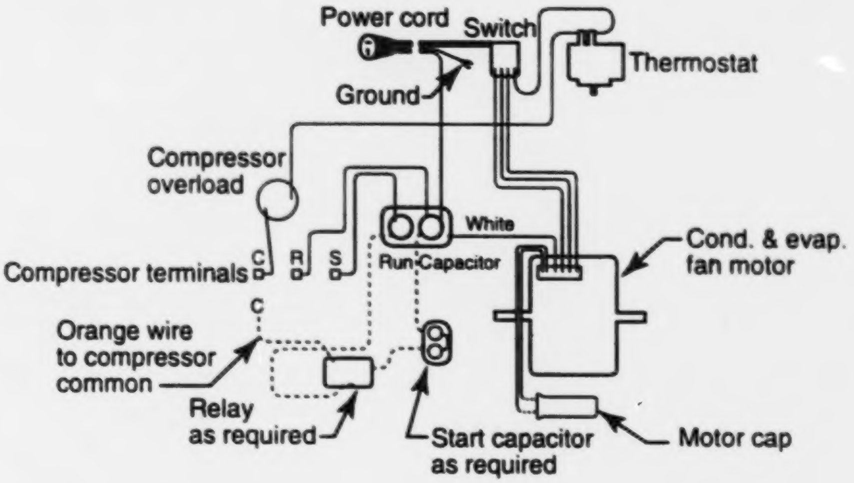
☐ 4. Read the installation instructions that come with the hard start kit.

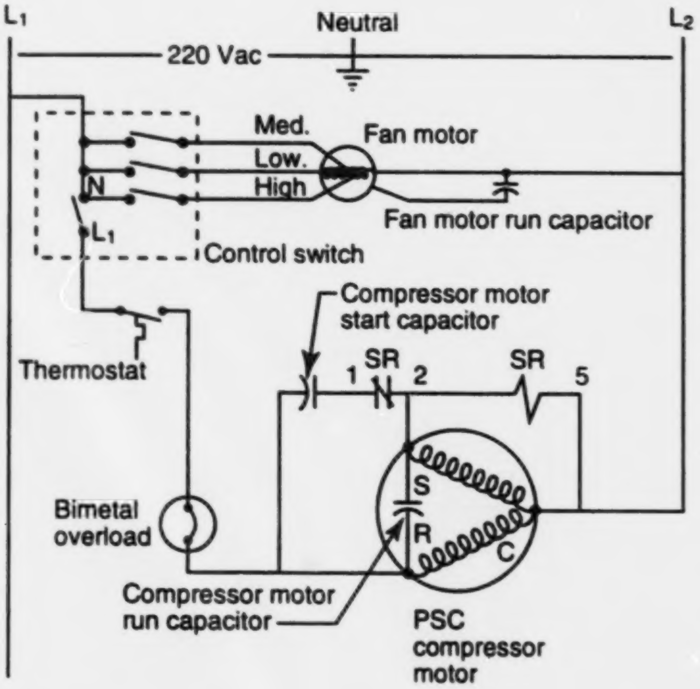
☐ 5. Install the relay and start capacitor in the control compartment.

Job Sheet 4

☐ 6. Study the wiring directions that came with the kit.

Note: The following diagram and schematic are typical of the materials required for hard start kit installation. Any kit you work with should be the same or similar to these.


Power cord
Switch
Thermostat
Ground
Compressor overload
White
Cond. & evap. fan motor
Compressor terminals
C
R
S
Run Capacitor
C
Orange wire to compressor common
Relay as required
Start capacitor as required
Motor cap


L1
Neutral
L2
220 Vac
Med.
Low.
High
Fan motor
N
L1
Fan motor run capacitor
Control switch
Compressor motor start capacitor
Thermostat
1
SR
2
SR
5
S
R
C
Bimetal overload
Compressor motor run capacitor
PSC compressor motor

Job Sheet 4

☐ 7. Connect a wire from #1 on relay to one side of the start capacitor.

☐ 8. Connect the other side of the start capacitor to the line voltage terminal of the run capacitor.

☐ 9. Connect a wire from #2 on the relay to the run capacitor terminal that is connected to START on the compressor motor.

☐ 10. Connect a wire from #5 on the relay to the terminal on the thermostat where the wire that goes to COMMON on the compressor motor is connected.

☐ 11. Have your instructor check your wiring.

☐ 12. Connect the air conditioning unit to a power source.

☐ 13. Set your ammeter to the highest scale.

☐ 14. Place the ammeter around the start wire.

☐ 15. Turn the air conditioning unit on; high amperage should last only a moment and then drop to very low.

☐ 16. Place an ammeter around the common wire and record the running amperage.

☐ 17. Turn the unit off, allow pressures to stabilize, restart and record starting amperage with the ammeter still around the common wire.

☐ 18. Have your instructor check your work.

☐ 19. Stop the air conditioner and disconnect the power cord.

☐ 20. Have a coworker help you reinstall the window air unit back into the cabinet.

☐ 21. Plug the window air unit into its power source and make sure the unit is operational.

☐ 22. Record operating temperatures and complete the Service Work Order that accompanies this job sheet.

☐ 23. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

____

____

Job Sheet 4

Service Work Order

Customer's Name ______________________________

Customer's Address ______________________________

Brief description of problem ______________________________

____

____

Time and date service or repair started ______________________________

Time and date service or repair ended ______________________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ______________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ______________

What amount of refrigerant was added? ______________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type?________ Amount? ______

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ______________ Date ______________

Job Sheet 4

Service Work Order

Evaluation of unit condition and general performance:

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressure after pressures have stabilized			
e. Liquid line pressure after pressures have stabilized			
f. Evaporator air temperature	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
g. Condenser air temperature	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
h. Additional information			
i. Additional information			
j. Technician's signature ______________ Date ________			

Window Air Conditioner Service
Unit 6

Job Sheet 5—Troubleshoot a Control Switch

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	Rating
Control switch wiring properly numbered or sketched	______
Ohmmeter continuity checks made on all switch positions	______
Switch reinstalled or new switch installed	______
Control switch positions verified as operational	______

A. Tools and materials

Window air conditioner as selected by instructor
Refrigeration technician's hand tools
Ohmmeter
Masking tape and marker
Safety glasses

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Mark the control switch wires with wire markers or use masking tape and use a marker to number them in an order you can follow when replacing them.

Note: If the control switch varies from a standard type, you may want to make a sketch to help you get wires back to the right contacts; continuity checks may vary from those that follow in this job sheet.

☐ 3. Remove the wires from the switch.

☐ 4. Remove the switch from the air conditioner.

☐ 5. Place the ohmmeter in the R x 1 position.

☐ 6. Zero the ohmmeter.

☐ 7. Attach one ohmmeter lead to L_1.

☐ 8. Place the control switch in the OFF position.

Job Sheet 5

☐ 9. Touch the other ohmmeter lead to terminals 1, 2, 3, and 4 one at a time in order.

☐ 10. Observe the ohmmeter when touching each terminal.

☐ 11. If the ohmmeter needle moves when you touch any one of the four terminals, the control switch has shorted contacts and should be replaced.

☐ 12. Place the control switch in the HIGH FAN position.

☐ 13. Touch the free ohmmeter lead to terminals 1, 2, 3, and 4 one at a time in order.

☐ 14. If the ohmmeter indicates continuity only between L_1 and terminal 4, the HIGH switch position is okay, but if there is continuity between L_1 and any terminal other than 4, the switch has shorted contacts and should be replaced.

☐ 15. Place the control switch in the LOW FAN position and repeat the previous tests to terminals 1, 2, 3, and 4.

☐ 16. Check for continuity between L_1 and terminal 3; any other continuity indicates shorted contacts and the switch should be replaced.

☐ 17. Place the control switch in the HIGH COOL position and make the checks to all four terminals.

☐ 18. Check for continuity between L_1 and terminal 1 and between L_1 and terminal 2; if there is continuity at other terminals, the switch should be replaced.

☐ 19. Place the control switch in the NORMAL COOL position and make the checks to all four terminals.

☐ 20. Check for continuity between L_1 and terminal 1 and between L_1 and terminal 4; if there is continuity at other terminals, the switch should be replaced.

☐ 21. Place the control switch in the LOW COOL position and make the check to all four terminals.

☐ 22. Check for continuity between L_1 and terminal 1 and between L_1 and terminal 3; if there is continuity at other terminals, the switch should be replaced.

☐ 23. Evaluate your troubleshooting results and decide if the old control switch is still good or if you need to install a new control switch.

☐ 24. Reinstall the old switch or the new switch into the air conditioner control panel.

☐ 25. Connect wires to the switch.

☐ 26. Have your instructor check your work.

Job Sheet 5

☐ 27. Connect the air conditioner to its power source and turn it on.

☐ 28. Start the air conditioner and run the control switch through all its positions.

☐ 29. Have your instructor verify your operating switch performance.

☐ 30. Turn the air conditioner off and disconnect it from the power source.

☐ 31. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

____

____

Job Sheet 5

Service Work Order

Customer's Name ______________________________

Customer's Address ______________________________

Brief description of problem ______________________________

____

____

Time and date service or repair started ______________________________

Time and date service or repair ended ______________________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ______________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ______________

What amount of refrigerant was added? ______________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type?________ Amount? ______

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ______________________ Date ______________

Job Sheet 5

Service Work Order

Evaluation of unit condition and general performance:

____

____

____

____

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressure after pressures have stabilized			
e. Liquid line pressure after pressures have stabilized			
f. Evaporator air temperature	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
g. Condenser air temperature	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
h. Additional information			
i. Additional information			

j. Technician's signature ________410________ Date __________

Window Air Conditioner Service
Unit 6

Job Sheet 6—Replace a Liquid Line Filter-Drier

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
Nitrogen circulated through system	______
Old drier properly removed	______
Mating ends of tubing properly cleaned	______
New drier properly brazed into place	______
New drier properly oriented with flow	______

A. Tools and materials

Window air conditioner as selected by instructor
Torch assembly
Heat shield(s) or heat block
Safety glasses and colored safety glasses
Sweat-type filter drier
Brazing rod
Flux, if needed
Sand cloth and/or wire brushes
Shop towels
Heat shield or heat block
Nitrogen cylinder w/regulator
Refrigeration technician's hand tools

B. Procedure

Special Note

This procedure is always performed as the last part of the assembly process. It assumes that refrigerant has been removed from the system and that the manifold gauge set is still attached to the system.

☐ 1. Put on colored safety glasses.

☐ 2. Attach the nitrogen cylinder to the low side of the system.

☐ 3. Set nitrogen regulator for 2 to 4 psig.

Job Sheet 6

☐ 4. Allow nitrogen to circulate through the system.

☐ 5. Check nearby components and set up a heat shield as required, and handle the torch safely in order to protect system components as you finish this activity.

☐ 6. Use the torch to heat up the end of the drier which has the capillary tube brazed into it while hold the cap tube with pliers.

Note: Some units may have only a screen or filter instead of a filter-drier.

☐ 7. When the brazing alloy liquifies, pull the cap tube out of the drier.

☐ 8. Use the torch to heat up the other end of the drier while holding the drier with the pliers.

☐ 9. When the brazing alloy liquifies, pull the drier off of the liquid line and place it in a safe place until it cools enough to safely handle before you dispose of it.

☐ 10. After lines cool sufficiently for handling, clean the end of the liquid line with sand cloth.

☐ 11. Clean the end of the cap tube from a point approximately 1 inch from the end to a point 2 inches from the end with sand cloth.

☐ 12. If the connecting ends show signs of not being thoroughly clean, apply silver brazing flux to the liquid line end and the cap tube end.

☐ 13. Remove the inlet end of the replacement drier; this may be a protective cap, an end which must be cut off, or an end which may be snapped off.

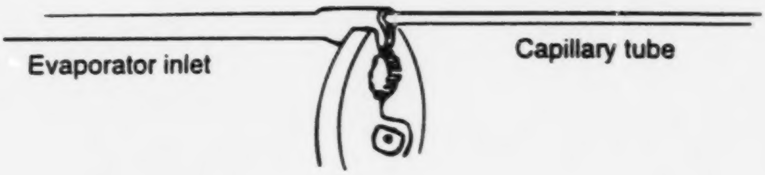
Note: Direction of flow is usually indicated by an arrow or other markings on the drier while some driers may be installed in either direction.

☐ 14. Twist the drier while placing it onto the liquid line.

Job Sheet 6

☐ 15. Insert the full 2-inch end of the cap tube into the outlet of the drier while making sure that the end does not hit against anything that might block the cap tube opening.

☐ 16. Pinch the tubing at the end of the drier to fit the cap tube.



☐ 17. Put on colored safety glasses, put heat shield(s) in place, and light the torch.

☐ 18. Braze both ends.

☐ 19. If flux was used, clean both joints with a damp cloth.

☐ 20. Continue with other procedures as needed or pressurize and leak check the system.

☐ 21. Complete the Service Work Order that accompanies this job sheet.

☐ 22. Have your instructor check your work.

☐ 23. Clean up area and return tools and materials no longer needed to proper storage or prepare for next job sheet as directed by your instructor.

Evaluator's Comments: ____

____

____

Job Sheet 6

Service Work Order

Customer's Name ____________________

Customer's Address ____________________

Brief description of problem ____________________

____

____

Time and date service or repair started ____________________

Time and date service or repair ended ____________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ____________________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ____________________

What amount of refrigerant was added? ____________________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type?________ Amount? ______

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ____________________ Date ____________

Job Sheet 6

Service Work Order

Evaluation of unit condition and general performance:

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressure after pressures have stabilized			
e. Liquid line pressure after pressures have stabilized			
f. Evaporator air temperature	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
g. Condenser air temperature	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
h. Additional information			
i. Additional information			
j. Technician's signature ____________ Date ________			

Window Air Conditioner Service
Unit 6

Job Sheet 7—Charge a WAC Using a Charging Cylinder

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
Refrigerant type and amount properly selected	______
Charging cylinder safely warmed	______
Cylinder oriented for liquid line charging	______
Cylinder oriented for low side charging	______
Operating pressures/temperatures recorded	______

A. Tools and materials

Window air conditioner as selected by instructor
Refrigerant per system specifications
Charging cylinder calibrated for selected refrigerant
Manufacturer's operating conditions chart or superheat charging chart
Thermometers
Safety glasses
Shop towels
Refrigeration technician's hand tools

B. Procedure

☐ 1. Put on safety glasses.

Special Note

This procedure is always performed as the last part of another service or repair process. It assumes that the system has been sealed, leak checked, and evacuated prior to this procedure and that the manifold gauge set is still attached to the system.

☐ 2. Check manufacturer's literature or data plate to determine the type and amount of refrigerant charge the system requires.

☐ 3. Fill the charging cylinder with the proper type and amount of refrigerant.

Note: Be sure the dial on the charging cylinder is set to the proper refrigerant and pressure reading.

Job Sheet 7

☐ 4. If charging cylinder has a built-in heater, plug it in and allow temperature and pressure to build up.

☐ 5. If charging cylinder does not have a built-in heater, another heat source such as a drop light, heat gun, or a blow dryer may be used to raise the temperature and pressure of the refrigerant.

Caution: Never apply a flame or excessive heat to a cylinder that has refrigerant in it!

☐ 6. Introduce refrigerant into the system through the liquid line if access is available.

☐ 7. When charging through the liquid line, hook the bottom valve of the charging cylinder to the system.

☐ 8. When charging through the low side, hook the top valve of the charging cylinder to the system.

☐ 9. Open the charging cylinder valve and purge the charging hose connecting the charging cylinder to the manifold gauge set.

☐ 10. When charging cylinder pressure reaches 150 psig, open the appropriate side of the manifold gauge set and allow the refrigerant to enter the system.

☐ 11. Approximately 15 seconds after liquid is no longer visible in the charging cylinder, discontinue application of heat.

☐ 12. Have your instructor check your work.

☐ 13. When charging through the low side, start the system after approximately three-fourths of the charge has entered the system.

☐ 14. If the charging cylinder does not have a heater and access is available to both the low side of the system and the liquid line, add refrigerant as a liquid until system and cylinder pressures equalize, start the system, and then finish charging through the low side; this is a simple, but effective time saver.

Caution: Never attempt to add refrigerant through the high side of a system while the compressor is running.

☐ 15. Disconnect the charging cylinder, and start the system, if you have not already started it.

☐ 16. Record pressures and temperatures on your Service Work Order that accompanies this job sheet, and compare them to the manufacturer's operating conditions chart or a superheat charging chart.

Job Sheet 7

☐ 17. Have your instructor check your results.

☐ 18. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

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Job Sheet 7

Service Work Order

Customer's Name ______________________________

Customer's Address ______________________________

Brief description of problem ______________________________

____

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Time and date service or repair started ______________________________

Time and date service or repair ended ______________________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

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____

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ______________________________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ______________________________

What amount of refrigerant was added? ______________________________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type?________ Amount? ______

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ______________________ Date ______________

Job Sheet 7

Service Work Order

Evaluation of unit condition and general performance:

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressure after pressures have stabilized			
e. Liquid line pressure after pressures have stabilized			
f. Evaporator air temperature	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
g. Condenser air temperature	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
h. Additional information			
i. Additional information			
j. Technician's signature 420 Date			

Window Air Conditioner Service
Unit 6

Job Sheet 8—Charge a WAC Using Charging Scales

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	Rating
Scales properly set up	______
Refrigerant charge properly measured	______
Cylinder upright or inverted as required	______
Operating temperature and pressures recorded	______

A. Tools and materials

Window air conditioner as selected by instructor
Refrigerant per system specifications
Charging scales
Manufacturer's operating conditions chart or equivalent
Thermometers
Safety glasses
Shop towels
Extra charging hose
Refrigeration technician's hand tools

B. Procedure

☐ 1. Put on safety glasses.

Special Note

This procedure is always performed as the last part of another service or repair process. It assumes that refrigerant has been sealed, leak checked, and evacuated prior to this procedure and that the manifold gauge set is still attached to the system.

☐ 2. Check manufacturer's literature or data plate to determine the type and amount of refrigerant charge the system requires.

☐ 3. When using automatic charging scales which have a built-in valve, attach the center gauge hose to the outlet port on the scales, and a separate hose to the refrigerant cylinder and the inlet port on the scales.

Job Sheet 8

☐ 4. When using charging scales which do not have a built-in valve, attach the center gauge hose directly to the refrigerant cylinder.

☐ 5. Open refrigerant cylinder valve and purge the hose connected to it.

☐ 6. When using automatic scales, program the scales to open the valve on the scale, and purge the hose from the outlet to the center of the gauge set.

☐ 7. Reset the scales to close the outlet port.

☐ 8. When charging through the high side, invert the refrigerant cylinder on the scales.

☐ 9. When charging through the low side, place the refrigerant cylinder upright on the scales.

☐ 10. Program scales for the specified amount of refrigerant charge, or zero the scales if they are not automatic.

☐ 11. If the scales are automatic, switch the scales to the charge setting.

☐ 12. Open appropriate gauge set valve and allow refrigerant to enter the system.

☐ 13. If scales are not automatic, shut valve when scales indicate the specified amount of refrigerant has entered the system.

☐ 14. If the system pressures equalize with the refrigerant cylinder before the specified amount of refrigerant has entered the system, check with your instructor, then start the system and complete charging through the low side, if access is available.

☐ 15. If low side access is not available, the scales and cylinder will have to be elevated above the system so gravity will make the refrigerant flow into the system after pressures have equalized.

Caution: Never attempt to add refrigerant through the high side of a system while the compressor is running.

☐ 16. Have your instructor check your work.

☐ 17. Start the system, if you have not already started it, and disconnect refrigerant cylinder and scales.

☐ 18. Record pressures and temperatures on your Service Work Order that accompanies this job sheet, and compare them to the manufacturer's operating conditions chart or a superheat charging chart.

Job Sheet 8

☐ 19. Have your instructor check your results.

☐ 20. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ______________________________

Job Sheet 8

Service Work Order

Customer's Name ____

Customer's Address ____

Brief description of problem ____

____

____

Time and date service or repair started ____

Time and date service or repair ended ____

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ____________________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ____________________

What amount of refrigerant was added? ____________________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type?________ Amount? ______

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ____________________ Date ____________

Job Sheet 8

Service Work Order

Evaluation of unit condition and general performance:

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressure after pressures have stabilized			
e. Liquid line pressure after pressures have stabilized			
f. Evaporator air temperature	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
g. Condenser air temperature	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
h. Additional information			
i. Additional information			

j. Technician's signature ________________ Date __________

Window Air Conditioner Service
Unit 6

Job Sheet 9—Evaluate a WAC Charge Using a Superheat Charging Chart

Name ________________________ Attempt Number ____________

Date ________________________ Overall Rating ____________

Evaluation Criteria	Rating
Thermometer properly attached to suction line	______
Manifold gauge set properly installed	______
Ambient temperature reading accurately made	______
Unit charge evaluated from temperature/pressure parameters	______
Service Work Order properly completed	______

A. Tools and materials

Window air conditioner as selected by instructor
Thermometer with remote sensing bulb
Ambient temperature thermometer
Manifold gauge set and P/T chart for refrigerant
Tape or velcro strap to secure thermometer to remote bulb sensing line
Pipe insulation to wrap around sensing bulb
Shop towel
Safety glasses

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Attach the thermometer sensing bulb securely to the suction line about 6" from where the line enters the compressor, and insulate the bulb with pipe wrap.

☐ 3. Attach the manifold gauge set to read suction pressure.

☐ 4. Start the unit and allow line pressures to stabilize for at least 15 minutes.

☐ 5. Read and record:

a) suction line pressure,

b) ambient temperature, and

c) suction line temperature.

☐ 6. Read across and down on the following superheat charging chart until you find the intersection that displays the temperature that your recorded suction line temperature should be.

Note: The following chart shows parameters for a reciprocal compressor; if you are working with a rotary compressor, see the chart at the end of this procedure.

Suction Line Temperature/Pressure Parameters for Reciprocal Compressors

OUTDOOR AMBIENT (°F)	SUCTION PRESSURE AT OUTDOOR SECTION (PSIG)																								
	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90	92	94	96	98
	SUCTION LINE TEMPERATURE (±3°F.)																								
65	37	42	47	53	59	64	69	71	75	79	82	85													
70	32	37	43	48	53	59	64	69	71	75	79	82	85												
75		33	38	43	49	54	59	65	69	72	76	79	83	85											
80			32	38	43	48	54	59	64	69	72	75	79	81	85										
85				32	38	41	48	53	58	64	69	71	75	78	81	84									
90						35	40	47	52	57	62	65	68	72	75	78	81	85							
95								40	44	49	54	59	62	66	70	73	76	79	82	85					
100										44	48	53	58	63	65	69	72	75	78	81	85				
105											42	47	50	55	60	66	69	71	75	78	80	83	86		
110													45	50	55	60	65	68	70	73	76	79	82		
115															51	55	60	63	66	69	72	75	78	81	84

Example: At 90°F outdoor temperature and at 68 psig suction pressure, the system will be correctly charged if the recorded suction line temperature is between 54°F and 60°F.

☐ 7. Should the suction line temperature read more than 3°F above or below the chart reading, the unit needs to be evaluated to determine the nature of the problem.

☐ 8. If the intersection figure falls into the blank area left or right on the chart, check the unit for:

- a) low indoor airflow,
- b) low outdoor airflow,
- c) refrigerant line restrictions,
- d) dirt filter and/or dirty evaporator coil,
- e) dirty or blocked condenser coil, or
- f) other abnormal conditions.

Job Sheet 9

☐ 9. If the unit conditions appear to be correct, and the unit suction line temperature is not within the 3°F limit above or below the chart figure, the unit is probably improperly charged and should be corrected according to the following:

a) if the suction line temperature is higher than the given value, the unit is undercharged.

b) if the suction line temperature is lower than the given value, the unit is overcharged.

☐ 10. Adjust or change unit parameters as your instructor directs.

☐ 11. Close the high side valve on the manifold gauge set.

☐ 12. Turn the unit off.

☐ 13. Complete the Service Work Order that accompanies this job sheet.

☐ 14. Have your instructor check your work.

☐ 15. Clean up area and return tools and materials to proper storage.

☐ 16. If WAC you are servicing has a rotary compressor, use the charging chart for rotary compressors.

Suction Line Temperature/Pressure Parameters for Rotary Compressors

OUTDOOR AMBIENT (°F)	SUCTION PRESSURE AT OUTDOOR SECTION (PSIG)																							
	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90	92	94	96	98
	SUCTION LINE TEMPERATURE (±3°F.)																							
65	33	38	43	49	54	59	65	69	72	76	79													
70		32	38	43	48	54	59	64	69	72	75	79												
75			32	38	41	48	53	58	64	69	71	75	78											
80					35	40	47	52	57	62	65	68	72	75										
85							40	44	49	54	59	62	66	70	73									
90									44	48	53	58	63	65	69	72	75							
95										42	47	50	55	60	66	69	71	75	78					
100												45	50	55	60	65	68	70	73					
105														51	55	60	63	66	69	72				
110																55	58	61	64	67	70	73		
115																		55	69	63	65	68	71	

Example: At 90°F outdoor temperature and 74 psig suction pressure, the unit will be correctly charged if the recorded suction line temperature is between 55°F and 61°F.

Job Sheet 9

Evaluator's Comments: ______________________________

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Job Sheet 9

Service Work Order

Customer's Name ______________________________

Customer's Address ______________________________

Brief description of problem ______________________________

____

____

Time and date service or repair started ______________________________

Time and date service or repair ended ______________________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ______________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ______________

What amount of refrigerant was added? ______________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type?________ Amount? ______

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ______________________ Date ______________

Job Sheet 9

Service Work Order

Evaluation of unit condition and general performance:

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressure after pressures have stabilized			
e. Liquid line pressure after pressures have stabilized			
f. Evaporator air temperature	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
g. Condenser air temperature	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
h. Additional information			
i. Additional information			

j. Technician's signature ______________________ Date ____________

Window Air Conditioner Service
Unit 6

Job Sheet 10—Service a Capillary Tube

Name ______________________________ Attempt Number __________

Date ______________________________ Overall Rating __________

Evaluation Criteria	**Rating**
System properly prepared for service	______
Original liquid line drier removed	______
Cap tube prepared and tested	______
Nitrogen circulated through system during service	______
Cap tube replaced and brazed as required	______
Drier replaced; system pressurized and leak checked	______
Operating temperatures and pressures recorded	______

A. Tools and materials

Window air conditioner as selected by instructor
Refrigeration technician's hand tools
Tubing cutter
Torch assembly
Heat shield(s) or heat block
Cap tube cleaner
Slim taper file
Slide caliper
Capillary tube gauge or orifice drill set
Manifold gauge set
Refrigerant recovery equipment
Dry nitrogen cylinder w/regulator
Leak detector
Assorted sizes of capillary tubing
Brazing alloy and flux
Filter-drier to system specifications

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Disconnect unit from electrical power.

☐ 3. Recover refrigerant and leave the gauge set attached to the low side.

☐ 4. Remove the liquid line drier per the procedure in Job Sheet 6.

☐ 5. Clean the end of the cap tube that you removed from the drier.

Job Sheet 10

☐ 6. Attach dry nitrogen cylinder to the center hose of the gauge set.

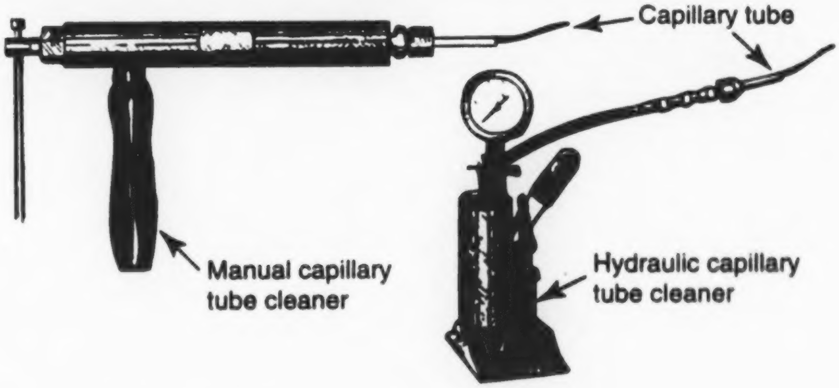
☐ 7. Set nitrogen regulator for 150 psig, or the maximum text pressure shown on the data plate, and while blocking the open end of the liquid line with a shop cloth, allow nitrogen to flow through the system.

Note: If the restriction is at the entrance to the cap tube, the nitrogen pressure may blow what is causing the restriction out of the system.

☐ 8. If nitrogen seems to be flowing freely from the end of the cap tube, proceed to Step 16.

☐ 9. If nitrogen does not seem to be flowing freely, check with your instructor before continuing.

☐ 10. If cap tube is still restricted, use a cap tube cleaner according to cleaner manufacturer's instructions to clean out the cap tube.


Capillary tube
Manual capillary tube cleaner
Hydraulic capillary tube cleaner

☐ 11. Repeat Steps 7 and 8.

☐ 12. If the cap tube is still restricted, replace the entire capillary tube.

☐ 13. If cap tube is damaged it can be repaired or a short section can be replaced with the following procedure:

a) Measure the inside and outside diameters of the capillary tubing with calipers and a capillary tube gauge or an orifice drill set.

b) Select new capillary tubing of the same size, and cut off exactly the same amount of tubing that you removed from the appliance.

Note: A different size cap tube may be used if the length is adjusted. See your instructor for procedure.

c) Cut a 4-inch piece of tubing with an inside diameter the size of the outside diameter of the capillary tube or slightly larger.

Job Sheet 10

d) Check to make sure that the end of the original cap tube in the appliance and both ends of the replacement tubing are not restricted in any way.

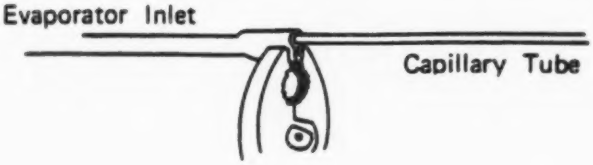
e) Pick a spot on the replacement piece of capillary tubing 1 inch from one end and then 1 1/2 inches of the tubing from that spot.

f) Repeat the procedure in item (5) with the end of the original cap tube.

g) Clean the inside of the 4-inch piece of tubing.

h) Insert the two cleaned ends of capillary tubing into the 4-inch piece so that the ends of the capillary tubing meet in the middle of the 4-inch piece.

i) Use pliers to pinch the 4-inch piece into place along the capillary tubing.



j) Braze both ends in place.

Note: Be sure heat shield(s) or heat block is in place before brazing.

☐ 14. Replace the liquid line drier.

☐ 15. Leak test, evacuate, and charge the system with the specified amount of refrigerant.

Note: Reference Job Sheets 6, 7, and 8 as needed.

☐ 16. Have your instructor check your installation.

☐ 17. Start system and record temperatures and pressures on the chart in the Service Work Order that accompanies this job sheet.

☐ 18. Have your instructor check your results.

☐ 19. Clean up area and return tools and materials to proper storage.

Job Sheet 10

Evaluator's Comments: ______________________________

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Job Sheet 10

Service Work Order

Customer's Name ____________________

Customer's Address ____________________

Brief description of problem ____________________

____

____

Time and date service or repair started ____________________

Time and date service or repair ended ____________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

____

____

____

____

Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ____________________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ____________________

What amount of refrigerant was added? ____________________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type? ________ Amount? ______

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ____________________ Date ____________

Job Sheet 10

Service Work Order

Evaluation of unit condition and general performance:

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressure after pressures have stabilized			
e. Liquid line pressure after pressures have stabilized			
f. Evaporator air temperature	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
g. Condenser air temperature	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
h. Additional information			
i. Additional information			
j. Technician's signature ______ 437 ______ Date ______			

Window Air Conditioner Service
Unit 6

Job Sheet 11—Replace a Compressor

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	Rating
Old compressor condition verified	______
Acid test kit used to check for burnout	______
System flushed with dry nitrogen	______
Replacement compressor brazed into place	______
Liquid line drier replaced	______
Suction line drier replaced (as required)	______
System pressurzied and leak checked	______
Operating temperatures and pressures recorded	______

A. Tools and materials

Window air conditioner as selected by instructor
Replacement compressor
Refrigeration technician's hand tools
Tubing cutter
Torch assembly
Heat shield(s) or heat block
Manifold gauge set
Refrigerant recovery equipment
Refrigerant to specifications
Dry nitrogen cylinder w/regulator
Leak detector
Brazing alloy and flux
Filter-drier to system specifications

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Check the appliance compressor to be sure that the original diagnosis of a faulty compressor is correct, even if the appliance is accompanied by written verification.

Note: If you replace a compressor that does not need to be replaced, the company may have to pay for it, or demand that you pay for it.

☐ 3. Disconnect the WAC from electrical power.

☐ 4. Recover refrigerant and leave the gauge set attached to the low side, if possible.

Job Sheet 11

☐ 5. Disconnect electrical connections and components from the compressor, and place them aside so they will not interfere with your work.

☐ 6. Detach or remove any other electrical or cabinet components that might interfere.

☐ 7. Remove the liquid line drier per the procedure in Job Sheet 6.

☐ 8. Disconnect tubing from the compressor by unsweating or cutting the lines.

☐ 9. Disconnect compressor mounting and remove the compressor.

☐ 10. If previous electrical checks of the original compressor showed open, shorted, or grounded windings, check for burnout.

☐ 11. Smell the original compressor for the distinctive odor of a burnout; you need to sniff the end of the suction stub.

Caution: Be extremely careful when handling the removed compressor; vapor and oil in the compressor and in the system may contain acid and other harmful substances.

☐ 12. If conditions in either Step 10 or 11 indicate a burnout, pour a small amount of oil out of the compressor into a small, clean container.

Caution: Use gloves when handling used compressor oil!

☐ 13. Follow the directions with your acid test kit to test the oil for acid.

☐ 14. Check the inside of the tubing that was connected to the original compressor for discoloration or other signs that will indicate the degree of cleanup that will be required.

Note: This will show you if acidic oil or other contaminants were pushed out into the tubing during burnout.

☐ 15. Remove and clean or replace any tubing, accumulator, or other components with severe contamination.

☐ 16. Connect dry nitrogen to the suction line; this may mean attaching an access valve.

☐ 17. Invert the dry nitrogen cylinder, and allow liquid nitrogen to flow through the system and flush out any contamination.

☐ 18. Right the nitrogen cylinder and disconnect.

Job Sheet 11

☐ 19. Compare original compressor mounting with replacement compressor mounting and the instructions that accompany the new compressor.

☐ 20. Check the replacement compressor to be sure it is the same or the equivalent of the original compressor.

☐ 21. Mount the replacement compressor in the WAC.

Note: If the new compressor mounts differently from the original compressor, you may have to reroute some of the tubing before mounting the new compressor.

☐ 22. Place heat shield(s) or heat block in place as needed.

☐ 23. Connect tubing to the new compressor and braze into place.

Note: In cases of severe burnout, a suction line filter-drier should be added, so make allowances in the suction line for addition of the filter-drier.

☐ 24. Replace the liquid line drier and braze suction line drier into place, if used.

☐ 25. Leak test, evacuate, and charge the system with the specified amount of refrigerant.

Note: Refer to Job Sheets 6, 7, and 8 as needed.

☐ 26. Have your instructor check your installation.

☐ 27. Start system and record temperatures and pressures on the chart in the Service Work Order that accompanies this job sheet.

☐ 28. Have your instructor check your results.

☐ 29. Clean up area and return tools and materials to proper storage.

Evaluator's Comments: ________________________________

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Job Sheet 11

Service Work Order

Customer's Name ______________________

Customer's Address ______________________

Brief description of problem ______________________

____

____

Time and date service or repair started ______________________

Time and date service or repair ended ______________________

Materials or equipment used to complete service or repair (continue list on back of form if needed)

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Was refrigerant removed from system during service? ☐ Yes ☐ No

If refrigerant was removed, what was the disposition of the refrigerant removed?

☐ Recovered on site and returned in total to the system at end of service.

☐ Recycled on site and returned in total to the system at end of service.

☐ Retained in approved recovery cylinder for future disposition.

If refrigerant was recovered and retained, include type and weight ______________

Was refrigerant added to the system as a part of service? ☐ Yes ☐ No

If refrigerant was added, what refrigerant was used? ______________

What amount of refrigerant was added? ______________

Were appropriate service tags left on system for future service reference? ☐ Yes ☐ No

Note: If you added refrigerant, the service tag should indicate both date and amount.

Was refrigerant oil added ☐ or removed ☐ from the system? Type? ________ Amount? ______

Was any amount of refrigerant vented to the atmosphere? If so, make an incident report.

Were "de minimus" venting guidelines observed during service? ☐ Yes ☐ No

Note: If your answer to the above question is No, explain the circumstances on the back of this form.

Signature of Service Technician ______________________ Date ______________

Job Sheet 11

Service Work Order

Evaluation of unit condition and general performance:

Operating Conditions Chart

Parameters	Initial Evaluation	Follow-up Evaluation 1	Follow-up Evaluation 2
a. Type of refrigerant			
b. Ambient temperature			
c. Static pressure			
d. Evaporator pressure after pressures have stabilized			
e. Liquid line pressure after pressures have stabilized			
f. Evaporator air temperature	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
g. Condenser air temperature	Entering: Exiting:	Entering: Exiting:	Entering: Exiting:
h. Additional information			
i. Additional information			

j. Technician's signature ________ 412 ________ Date ________